PROCESSING TURKISH CENTER-EMBEDDINGS: AN INVESTIGATION OF CASE INTERFERENCE AND PROSODIC PHRASE LENGTHS

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An Investigation of Case Interference and Prosodic Phrase Lengths

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DECLARATION OF ORIGINALITY

I, Özge Bakay, certify that

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ABSTRACT

Processing Turkish Center-Embeddings:

An Investigation of Case Interference and Prosodic Phrase Lengths

This study investigated the processing difficulty associated with Turkish center-embeddings. Two off-line end-of-sentence acceptability judgment tasks (Experiments 1 and 2) and an eye-tracking experiment were conducted to examine (i) if the processing difficulty of Turkish center-embeddings is influenced by similarity-based interference (e.g., Lewis & Vasishth, 2005) and/or prosodic phrase lengths (Fodor, 2013), (ii) if missing-VP2 illusion (Frazier, 1985) exists in Turkish center-embeddings, and (iii) if the illusion (if it existed) is modulated by similarity-based interference and/or prosodic phrase lengths. The judgment tasks showed that contra the predictions of the similarity-based interference decreasing syntactic interference did not ease the processing difficulty of Turkish center-embeddings, but prosodic phrase lengths encouraging optimal phrasing of the sentence resulted in an easier processing of the construction. There was overall no missing-VP2 illusion in Turkish center-embeddings, but the illusion was observed in the sentences with decreased syntactic interference and discouraging phrase lengths, suggesting that missing-VP2 illusion may be cross-linguistic (Gibson & Thomas, 1999). The results from the eye-tracking experiment showed that decreasing syntactic interference and encouraging phrase lengths facilitated processing Turkish center-embeddings; phonological interference did not affect their processing difficulty, though. Overall, the findings supported the predictions of the similarity-based interference and prosodic phrase lengths accounts and extend them to Turkish.

ÖZET

Türkçede İç İçe Yerleşik Tümce Yapılarının İşlemlenmesi: Durum Eki Müdahalesi ve Bürünsel Öbek Uzunluğunun Bir İncelemesi

Bu çalışma Türkçede iç içe yerleşik tümce yapılarının işlemlenmesini incelemektedir. İki tümce sonu kabul edilebilirlik puanlaması çalışması (1. ve 2. Deney) ve bir göz izleme deneyi (3. Deney) ile (i) Türkçede iç içe yerleşik tümce yapılarındaki işlemleme zorluğunun benzerlik-odaklı müdahale (ör., Lewis & Vasishth, 2005) ve/veya bürünsel öbek uzunluğuna (Fodor, 2013) bağlı olarak değişip değişmediği, (ii) Türkçe iç içe yerleşik tümcelerde kayıp-ikinci-fiil yanılsamasının (Frazier, 1985) olup olmadığı ve (iii) benzerlik-odaklı müdahale ve/veya bürünsel öbek uzunluğunun (varsa) kayıp-ikinci-fiil yanılsamasını etkileyip etkilemediği araştırılmıştır. Kabul edilebilirlik puanlamalarının sonuçları tahmin edilenin aksine düşük sözdizimsel müdahalenin incelenen tümce yapılarının işlemleme zorluğunu değiştirmediğini, fakat ideal gruplamayı destekleyen bürünsel öbek uzunluğunun bu tümcelerin işlemlenmesini kolaylaştırdığını göstermiştir. Genel olarak bakıldığında incelenen tümcelerde kayıp-ikinci-fiil yanılsaması yokken düşük sözdizimsel müdahale ve destekleyici olmayan bürünsel öbek uzunluklarına sahip tümcelerde yanılsamanın olduğu gözlemlenmiştir. Bu sonuçlar kayıp-ikinci-fiil yanılsamasının tüm dillerde var olduğu görüşünü desteklemektedir (Gibson & Thomas, 1999). Göz izleme deneyinin sonuçları incelenen tümce yapısının düşük sözdizimsel müdahale ve destekleyici bürünsel öbek uzunluklarıyla daha kolay işlemlendiğini, fakat sesbilimsel müdahalenin bir etkisinin olmadığını göstermiştir. Özetle, çalışmanın bulguları benzerlik-odaklı müdahale ve bürünsel öbek uzunluğu açıklamalarını Türkçeden veri ile desteklemiştir.

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ABBREVIATIONS

1	first person
3	third person
ABL	ablative
ACC	accusative
DAT	dative
ERG	ergative
GEN	genitive
INF	infinitival
NOM	nominative
PART	participle
PF	perfective
PL	plural
POSS	possessive
PROG	progressive
SG	singular
SUB	subordinator
TOP	topicalized
VN	verbal nominal

CHAPTER 1

INTRODUCTION

1.1 Introduction

This thesis investigates if the processing difficulty of Turkish center-embeddings can be modulated by similarity-based interference and/or prosodic phrase lengths. The thesis also examines if there is a missing-VP2 illusion in Turkish center-embeddings and if it exists for Turkish center-embedded sentences, whether or not its prominence could be modulated by similarity-based interference and/or prosodic phrase lengths. Doubly center-embeddings with relative clauses (2-CE-RCs) such as *The rat that the cat that the dog chased ate died* (Chomsky & Miller, 1963, p. 286) are reported to be extremely difficult to process despite their grammaticality. Several accounts have been proposed to explain the extreme processing difficulty associated with 2-CE-RCs. Two of these accounts, namely the similarity-based interference and prosodic phrase lengths accounts, are tested in this study. The interference-based account maintains that the greatest difficulty in processing center-embedded structures occurs at VP2, *ate*, due to the presence of two similar subject NPs that can be retrieved for VP2: NP1, *the rat,* and NP2, *the cat* (e.g., Lewis, 1996; 1998; Lewis & Vasishth, 2005; Lewis, Vasishth, & van Dyke, 2006). Thus, decreasing the similarity among the subject NPs is predicted to ease the processing of 2-CE-RCs. A number of studies that have investigated the role of similarity-based interference in processing center-embedded structures both in off-line and on-line measures have revealed that a decrease in the number of NPs that are similar in terms of their syntactic (Lewis & Nakayama, 1999; 2002; Uehara, 2003; Uehara & Bradley, 2002 for Japanese), positional (Lewis & Nakayama, 1999; 2002 for Japanese; Vasishth, 2003 for Hindi),

phonological (Nakayama, Lee, & Lewis, 2005 for Korean; Vasishth, 2003 for Hindi; but cf. Uehara & Bradley, 1996 for Korean) and/or semantic features (Nakayama et al., 2005 for Japanese; but cf. Lewis & Nakayama, 2002; Nakayama et al., 2005 for Japanese) facilitated the processing difficulty of center-embedded structures. But, to my knowledge, no study has tested the effects of similarity-based interference in Turkish center-embeddings. Therefore, this study aims to find out whether interference due to similar syntactic (the same case markings that indicate syntactic functions of NPs) and phonological (identical phonological form of case markings) features modulates the processing difficulty of Turkish center-embeddings.

The prosodic phrase lengths account, on the other hand, attributes the extreme processing difficulty of 2-CE-RCs to the incongruency between their (implicit) prosodic phrasing and syntactic structure (Fodor, 2013). That is, an optimal phrasing that is induced by optimal and balanced phrase lengths whose prosodic boundaries align with the syntactic structure of the sentence, e.g., NP1 || RC1 || VP1 for English 2-CE-RCs, is predicted to ease the processing of the center-embedded structures. Although this prediction has been tested and confirmed in English 2-CE-RCs (Nickels & Fodor, 2011; Fodor, Nickels, & Schott, 2017; Fodor, Macaulay, Ronkos, Callahan, & Peckenpaugh, 2019), to my knowledge, it has not been investigated in any other language. One of the aims of this study is, thus, to examine whether or not the prosodic phrase lengths account can be extended to languages other than English, and whether or not an optimal phrasing for Turkish center-embeddings, viz., NP1 || NP6 || VP1, that is induced by optimal and balanced phrase lengths can facilitate the processing of Turkish center-embeddings.

The processing of center-embedded structures is so difficult that the omission of the second verb, i.e., VP2, from the structure has been observed to be unnoticed,

resulting in a grammaticality illusion, more specifically, missing-VP2 illusion. This was first noted by Lyn Frazier (1985) who attributed the observation to Janet Fodor. Four main accounts have been proposed to explain the missing-VP2 illusion: (i) the resource-based account, (ii) the experience-based accounts, (iii) the interference-based account and (iv) the prosodic phrase lengths account. The resource-based account attributes the illusion to working memory limitations, and states that in the case of high memory overload, the predictions of VP2, which is associated with the highest memory load in the sentence, are forgotten (Gibson & Thomas, 1999). The resource-based account predicts the illusion to occur cross-linguistically presumably because the human parsing mechanism is mostly defined to be universal and the constraints that it encounters would apply to all languages. The predictions of the resource-based account have been confirmed in English (Gibson & Thomas, 1999) and French (Gimenes, Rigalleau, & Gaonac'h, 2009). The experience-based accounts, on the other hand, claim that missing-VP2 illusion is modulated by the headedness properties of a language, and the illusion may not exist in verb-final languages (Frank & Ernst, 2018; Frank, Trompenaars, & Vasishth 2016; Vasishth, Suckow, Lewis, & Kern, 2010). The experience-based accounts do not predict a missing-VP2 illusion in verb-final languages because in these languages working memory predictions for upcoming verbs are expected to be more robust (Vasishth et al., 2010). These predictions have been confirmed in German (Engelmann & Vasishth, 2009; Huang & Philips, 2020; Vasishth et al., 2010), Dutch (Frank & Ernst, 2018; Frank et al., 2016; Huang & Philips, 2020; for Dutch) and Hindi (Husain & Bhatia, 2018) (but cf. Huang & Philips, 2020 for Mandarin and Dokudan, Ergin, & Logačev, 2017 for Turkish). Unlike German and Dutch, which are verb-final only in subordinate clauses, Turkish is verb-final in both subordinate and matrix

clauses. Hence, the relatively stricter head-final property of Turkish would allow for a good testing ground for the predictions of the resource- and experience-based accounts for the universality of missing-VP2 illusion.

The two accounts of center-embedding difficulty that are under investigation in this study, namely the interference-based and prosodic phrase lengths accounts, also have explanations for the missing-VP2 illusion. The interference-based account attributes missing-VP2 illusion to similarity-based interference effects that arise in retrieving the correct subject NP for VP1, the final VP (e.g., Bader, 2015; Häussler & Bader, 2015). In ungrammatical sentences with a missing VP2, VP1 is the second verb; and hence, the point of most processing difficulty. Upon processing VP1, there are two similar subject NPs that can be retrieved: the first subject NP (NP1) and the second subject NP (NP2). Due to its primacy advantage, NP1 can be correctly retrieved for VP1, and the lack of a VP for NP2 may be unnoticed, leading to a grammaticality illusion. These predictions of the interference-based account have been confirmed in German (Bader, 2015; Häussler & Bader, 2015), in English (Huang & Philips, 2020), and Mandarin (Huang & Philips, 2020). This study tests the predictions of the interference-based account for the role of syntactic interference on missing-VP2 illusion in Turkish center-embeddings.

The prosodic phrase lengths account attributes the missing-VP2 illusion to the non-optimal prosodic phrasing of the sentence (Fodor, 2013). In this account, the illusion occurs in the center-embedded structures that are phrased non-optimally and have unbalanced phrase lengths because the correct syntactic structure of the sentence is less likely to be built for these sentences. If a center-embedded sentence has an optimal and balanced phrasing, the missing-VP2 illusion is not expected to occur since the processing of the sentence is predicted to be eased, and a missing VP

can more easily be recognized. These predictions have been confirmed in English center-embeddings (Schott & Fodor, 2013; Fodor et al., 2017), but, to my knowledge, they have not been tested in any other language. Thus, this study examines whether the predictions of the prosodic phrase lengths account for missing-VP2 illusion can be extended to Turkish.

The present study employed Turkish doubly center-embedded structures with relative clauses (2-CE-RCs) as experimental stimuli. In the experimental stimuli the Turkish 2-CE-RCs were further nested as complement clauses inside matrix clauses for the interference manipulation (see Chapter 2 for details). Although the majority of the studies on head-final languages employed center-embedded structures with sentential complements as their experimental stimuli (Lewis & Nakayama, 1999; 2002; Nakayama et al., 2005; Uehara, 2003; Uehara & Bradley, 1996 for Japanese; Nakayama et al., 2005; Uehara & Bradley, 1996 for Korean; Vasishth, 2003 for Hindi; Dokudan et al., 2017 for Turkish), the present study employs 2-CE-RCs in Turkish because structurally 2-CE-RCs in Turkish appear to be more comparable to the 2-CE-RCs in head-initial languages such as English (e.g., Gibson & Thomas, 1999) or French (Gimenes et al., 2009) than center-embedded structures with sentential complements (see Chapter 3 for details). In this regard, this study is the first to investigate the processing difficulty of Turkish center-embeddings with 2-CE-RCs.

Two end-of-sentence acceptability judgment tasks (Experiments 1 and 2) and one eye-tracking study (Experiment 3) were conducted. The acceptability judgment tasks tested whether or not there was a missing-VP2 illusion in Turkish center-embeddings. Experiment 1 also tested the predictions of the interference-based account (i.e., effects of syntactic interference) for missing-VP2 illusion as well as its

predictions for the perceived difficulty of center-embedded structures. Experiment 2 examined the predictions of the prosodic phrase lengths account for missing-VP2 illusion as well as its predictions for the perceived difficulty of center-embedded structures. Experiment 3, the eye-tracking experiment, investigated the real-time effects of interference (i.e., syntactic and phonological interference) and prosodic phrase lengths in processing center-embedded sentences in Turkish.

1.2 The organization of the thesis

The remainder of the thesis is organized around three chapters. Chapter 2 presents a review of the previous literature on the sources of the difficulty associated with center-embedded sentences, explanations for missing-VP2 illusion and the studies that tested these predictions. Chapter 3 presents the present study and reports on the results of the end-of-sentence acceptability judgment tasks and the eye-tracking experiment. Finally, Chapter 4 concludes with a summary of the findings and provides a discussion of the findings and their relation to the literature on center-embedding difficulty and missing-VP2 illusion.

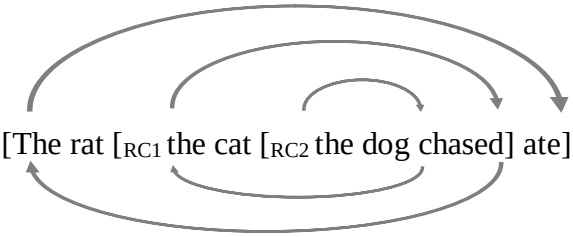
CHAPTER 2

THE PROCESSING DIFFICULTY IN CENTER-EMBEDDED STRUCTURES

The human sentence comprehension mechanism (henceforth, the parser) is known to be fairly rapid and efficient in its computation of the structural and semantic representations of a sentence. This mechanism is assumed to be incremental in its computation of these representations (Frazier, 1978; Frazier & Fodor, 1978; among others). That is, the incoming words are attached into the structure that has been processed until that far. Although the parser mostly functions efficaciously, it is also subject to certain computational limitations.

A prominent example where the parser faces such a limitation is center-embedded structures. Center-embedded structures, referred to as "nesting of dependencies" by Miller and Chomsky (1963), are constructed with embedding a constituent *X* in another constituent *Y* such that constituent *X* is both preceded and followed by some material of *Y*. A special type of center-embedded structures is self-embedding, which is the nesting of constituents belonging to the same category. The sentence in (1) is an example of a self-embedding (note that self-embeddings are commonly referred to as center-embeddings in the literature; similarly, in this thesis the term center-embedding will be used to refer to sentences with one, two or more levels of self-embeddings). The arrows on the top show subject-verb relationships and the arrows at the bottom show verb-object relationships; the numbering of the noun phrases (NPs) and verb phrases (VPs) denote subject-verb dependencies. But note that in some studies NPs and VPs are numbered based on their linear order, i.e., NP1-NP2-NP3-VP1-VP2-VP3 (Gibson & Thomas, 1999; Fodor, 2013; Frank & Ernst, 2018; Frank et al., 2016). The numbering in (1), i.e., NP1-NP2-NP3-VP3-

VP2-VP1, will be adopted throughout the thesis for both the previous studies and the present examples.



(Chomsky & Miller, 1986, p. 286)

In (1), there are three consecutive NPs followed by three consecutive VPs. The NPs and VPs are nested with two object relative clauses (RCs). The object RC *the cat … ate* is nested within the sentence *the rat … died.* A second object RC *the dog chased* is nested within the first embedded sentence *the cat … ate*. NP1, *the rat,* is both the subject of the matrix clause and the object of the first embedded clause. Similarly, NP2, *the cat,* is both the subject of the first embedded clause and the object of the second embedded clause. Figure 1 below further illustrates the subject-verb relations and the nesting of RCs in the sentence in (1).

[1] Here, and throughout all the examples in the thesis, [ ] are used to show clause boundaries.

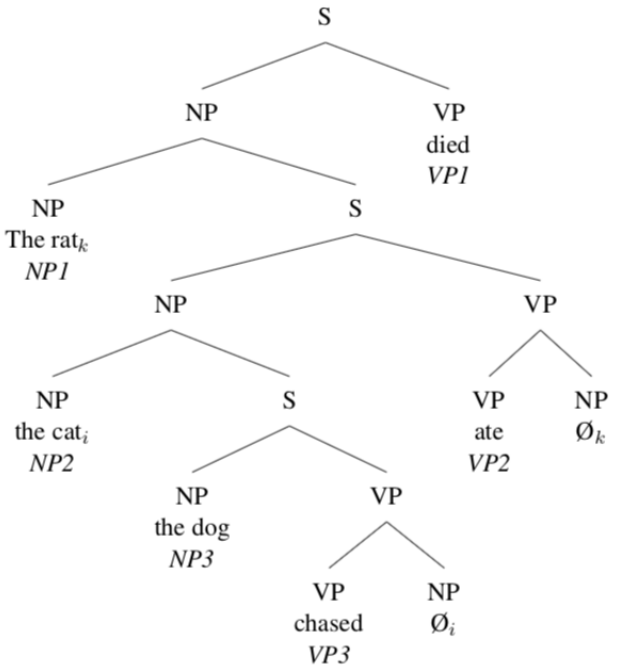


Figure 1. Surface structure of the center-embedded sentence in (1)

Marks (1968) argues that doubly center-embedded structures are ungrammatical and Reich (1969) proposes that grammatical center-embedded constructions are limited to one level of embedding in any language. The discussion on the (un)grammaticality of doubly center-embedded structures (henceforth, 2-CE-RCs) usually focus on the rare occurrence of center-embedded structures in daily use (e.g. Karlsson, 2007) (see De Roeck et al., 1982 for the details of the discussion on the grammaticality of doubly center-embedded structures.) But 2-CE-RCs are nevertheless widely considered to be grammatical (Chomsky & Miller, 1963; Miller & Chomsky, 1963; but cf. Marks, 1968; Reich, 1969) especially because human language grammars permit the production of an infinite number of sentences without any limits on recursion (Chomsky, 1957). Miller and Chomsky maintain that although the sentence in (1) is "confusing and improbable", it is grammatical with an unambiguous meaning (Miller & Chomsky, 1963, p. 286).

2-CE-RCs, despite their grammaticality, are notoriously known to pose extreme difficulty to the parser, though (Bever, 1970, Chomsky & Miller, 1963; Gibson, 1991; 1998; 2000; Frazier & Fodor, 1978; Kimball, 1973; Lewis, 1993; Miller & Chomsky, 1963; Miller & Isard, 1964; among others). The contrast between the grammaticality and processability of 2-CE-RCs is taken as a realization of the difference between competence and performance of the human language user, which Miller and Isard (1964) explained as follows:

> [t]he fact that an indefinite number of self-embeddings is grammatically acceptable, yet at the same time psychologically unacceptable, would seem to imply that a clear distinction is necessary between our theory of the language and our theory of the language user. (p. 294)

The extreme processing difficulty encountered in center embeddings has been discussed with respect to right- and left-branching structures (Bever, 1970; Chomsky & Miller, 1963; Gibson, 1991; Kimball, 1973; Lewis, 1993; Miller & Chomsky 1963; Miller & Isard, 1964; Yngve, 1960). The right-branching structures as in (2a), for instance, are considered to be much more comprehensible than the center-embedded structures as in (2b) although the two structures are equal in their length and number of embeddings.

(2) a. [Jack met the patient] [who was admitted by the nurse] [who the clinic had hired.]

b. [The patient [who the nurse [who the clinic had hired] admitted] met Jack.]

(Gibson & Thomas, 1999, p. 226)

Similarly, the left-branching structures as in (3a) are considered to be much easier to process than the center embedded structures as in (3b).

(3) a. [Joe's leaving's] [bothering Susan] [surprised Max.]

b. [That [that [Joe left] bothered Susan] surprised Max.]

(Kimball, 1973, p. 33-34)

Several accounts have been proposed to explain the extreme processing difficulty of 2-CE-RCs as in (2b) and (3b) compared to (2a) and (3a). These approaches attribute the difficulty in 2-CE-RCs to limited human memory (Miller & Chomsky, 1963), structural density (Fodor & Garrett, 1967), double function of NPs (Bever, 1970), the integration cost of syntactic dependencies (Gibson, 1998; 2000), difficulty in processing more than two sentences at a time (Kimball, 1973), interference in short-term memory (Lewis, 1996; 1998; 2000; Lewis & Vasishth, 2005; Lewis et al., 2006) or lack of alignment in syntax-prosody interface (Fodor, 2013). These accounts will be discussed in further detail in the following sections of this chapter. But before that, the conditions that have been argued to ease processing of 2-CE-RCs will be discussed. 2-CE-RCs are argued to be more comprehensible under two conditions: (i) using a pronoun for NP3 and (ii) omitting VP2.

The first assumption maintains that sentences as in (4), in which the subject of the most deeply embedded relative clause, namely NP3, is a pronoun (*I* in (4)), are easier to comprehend than those as in (1), (2b) and (3b) where NP3 is a lexical noun (Bever, 1970, 1974; Gibson, 1998; Kac, 1981; Warren & Gibson, 2002).

(4) [The rat [that the cat [I saw] chased] squeaked.]

(Kac, 1981, p. 124)

This observation, first pointed out by Bever (1970), was confirmed by experimental evidence from complexity judgments and reading times in Warren and Gibson's (2002) study. Bever (1970, 1974) suggests that the processability of center-embedded structures improves in (4) because the syntactic similarity of the three

subject NPs decreases when NP3 is a pronoun. Gibson (2000), however, argues that sentences as in (4) are easier to process because processing a previously-constructed discourse referent such as a pronoun, e.g., *I* in (4), requires fewer resources than building a new discourse structure, e.g., *the clinic* in (2b) (see Section 2.2 for a detailed discussion of Gibson's account).

The second assumption maintains that the omission of the second verb in a 2-CE-RC goes unnoticed (because of the difficulty to process the construction), and the ungrammatical sentence with a missing verb as in (5b) is perceived to be grammatical and to be even easier to process than its grammatical version as in (5a).

(5) a. [The patient [$_{RC1}$who the nurse [$_{RC2}$who the clinic] had hired]
NP1 NP2 NP3 VP3

admitted] met Jack.]
VP2 VP1

b. [The patient [$_{RC1}$who the nurse [$_{RC2}$who the clinic] had hired]
NP1 NP2 NP3 VP3

~~admitted~~] met Jack.
VP2 VP1

(Frazier, 1978, p. 178)

The observation of the grammaticality illusion in 2-CE-RCs with a missing verb was attributed to Janet Dean Fodor (Frazier, 1985). In her *disappearing syntactic nodes hypothesis*, Frazier argued that at points of high complexity the parser may tend to concentrate its limited resources to remembering the syntactic nodes that dominate no lexical items or those that dominate lexical items without a semantic interpretation, and "forget" the ones that are already semantically interpreted. In the ungrammatical sentence with a missing VP2 as in (5b), when the parser processes VP3, *had hired*, two thematic roles are assigned: a subject role to NP3, *the clinic*, and an object role to the pronoun of RC2 that is co-indexed with NP2, *the nurse*.

Therefore, upon processing VP3, NP2 and NP3 already have semantic interpretations and thus, they can be pruned away from the structure. Similarly, RC1 and RC2 that modify NP2 and NP3, respectively, can also be pruned away from the structure since they no longer dominate a lexical material that is present in the structure. When processing VP1, *met Jack*, the parser assumes that VP1 is the predicate of NP1, *the patient*, because at that point NP1 is the only lexical material that does not have a semantic interpretation. VP1, *met*, is then associated with NP1 as its predicate and the matrix verb of the sentence, and the sentence is perceived as grammatical. During this process the subject role to NP2 that would be assigned by VP2, *admitted*, is not assigned, but it goes unnoticed because there is no semantically uninterpreted material in RC1 (i.e., NP2 has already received the object role from VP3), which leads to a grammaticality illusion. This conspires with the fact that there is one less semantic interpretation of NP2, i.e., the subject role of VP2, presumably contributing to the easier processing of (5b) compared to (5a).

The assumption that using a pronoun for NP3 eases the processing of 2-CE-RCs is widely recognized. On the contrary, the grammaticality illusion for 2-CE-RCs with a missing verb has been controversial in the literature. While some studies have shown evidence for missing-VP2 illusion in 2-CE-RCs (Christiansen & MacDonald, 2009; Engelmann & Vasishth, 2009; Frank & Ernst; 2018; Frank et al., 2016; Futrell & Levy, 2017; Futrell, Gibson, & Levy, 2020; Gibson & Thomas, 1999; Huang & Philips, 2020; Vasishth et al., 2010 for English; Gimenes et al., 2009 for French; Bader, 2015; Häussler & Bader, 2015 for German; Dokudan et al., 2017 for Turkish), others have presented counter-evidence, i.e., lack of illusion (Engelmann & Vasishth, 2009; Huang & Philips, 2020; Vasishth et al., 2010 for German; Frank & Ernst,

2018; Frank et al., 2016; Huang & Philips, 2020 for Dutch; Husain & Bhatia, 2018 for Hindi).

In the remainder of this chapter I will report on the accounts that have been proposed to explain the extreme processing difficulty associated with doubly center-embedded structures and the studies, if any, conducted to test these accounts. I will further report on how those accounts explain, if they do, the missing-VP2 illusion in the processing of the structure.

2.1 Structure-based accounts

Most of the early accounts attribute the difficulty associated with 2-CE-RCs to their syntactic structures. One of the earliest accounts maintains that processing 2-CE-RCs is difficult because of *self-embedding* (Babyonyshev & Gibson, 1995; Kuno, 1974; Yngve, 1960; among others). In this account the cause of the difficulty is the successive center-embedding of clauses that have the same grammatical function. This account hypothesizes that center-embedded sentences that include the nesting of the same type of clauses as in (6a) are harder to process than center-embedded sentences that include the nesting of different types of clauses as in (6b).

(6) a. [The cheese [$_{RC1}$ that the rat [$_{RC2}$ that the cat chased] ate] was rotten.]

b. [The cheese [$_{RC}$ that the rat [$_{AC}$ while the cat chased it] ate] was rotten.]

(Kuno, 1974, p. 124)

In the sentence in (6a), the RC2, *that the cat chased,* is nested within another RC, RC1, *that the rat … ate.* In the sentence in (6b), the adverbial clause (AC), *while the cat chased it,* is nested in an RC, *that the rat … ate.* Thus, the nesting of same type of

embedded clauses as in (6a) was claimed to reduce the processability of center-embedded structures.

Another account of center-embedding difficulty maintains that the difficulty is indexed by the number of incomplete syntactic dependencies that need to be kept in memory on a stack (Chomsky & Miller 1963; Miller & Chomsky 1963; Miller & Isard 1964; Yngve 1960). Examine the singly center-embedded sentences such as (7a) and doubly-center-embedded sentences such as (7b) for a comparison of processability under this account.

(7) a. [The rat [$_{RC1}$ the cat ate] died.]

b. [The rat [$_{RC1}$ the cat [$_{RC2}$ the dog chased] ate] died.]

(Chomsky & Miller, 1963, p. 286)

In the sentence in (7a) there are at most three incomplete syntactic dependencies at the point of processing *the cat:* (i) the NP, *the rat*, is dependent on a predicate; (ii) the NP, *the cat,* is dependent on a different predicate; and (iii) the RC1, *that the cat,* is dependent on a predicate, which is the same predicate that *the cat* is dependent on. In the sentence in (7b), however, there are at most five incomplete syntactic dependencies at the point of processing *the dog*: the same three incomplete dependencies as in (7a), (iv) the NP, *the dog,* is dependent on a different predicate, and (v) the RC2, *the dog chased,* is dependent on a predicate, which is the same predicate as *the dog* is dependent on. Thus, doubly center-embedded sentences as in (7b) are more difficult than singly center-embedded sentences as in (7a) due to a higher number of incomplete syntactic dependencies.

This observation was empirically investigated by Miller and Isard (1964) and Lewis (1996), who demonstrated that the processability of center-embedded structures decreased as the number of embeddings increased (for similar results

regarding the contrast between singly and doubly center-embedded structures, see Mazuka et al. (1989) (this section) and Uehara (2003) for Japanese (Section 2.4.2); Uehara & Bradley (1996) for Korean (Section 2.4.2); Vasishth (2003) for Hindi (Section 2.4.2)). Although Miller and Isard (1964) and Lewis (1996) suggested doubly and/or triply center-embeddings as potential limits for processability, there has been no conclusion in the literature as to the upper limit of processable nested structures (e.g., Bever, 1970; Greene, 1972; Pulman, 1986; Reich, 1969; Sampson; 1996).

An alternative explanation for the difficulty of 2-CE-RCs was proposed by Bever (1970). Bever argued that the processing difficulty in 2-CE-RCs is due to the double function that the NP2 must be assigned with. Due to this double function, the NP2 serves two opposite functions at the same time:

> in a sequence of constituents x, y, z, if x had an internal relation R_i to y and y has the same internal relation to z, and x, y, and z are superficially identical, then the stimulus is relatively complex, due to y's double function in the perceptual strategy. (p. 61)

In the sentence in (8), the NP2, *the cat*, has two separate functions; it is both the subject of VP2, *ate*, and the object of VP3, *chased.*

(8) [The rat [the cat [the dog chased] ate] died.]
NP1 NP2 NP3 VP3 VP2 VP1

(Chomsky & Miller, 1963, p. 286)

Blumenthal (1966), however, noted that the processing difficulty in (8) could also be due to the presence of three consecutive NPs in 2-CE-RCs. Based on empirical data from a re-writing task, Blumenthal showed that the three consecutive NPs misled the parser towards the interpretation of the first three NPs as coordination. Fodor and Garrett (1967) further reported that the coordination interpretation disappeared when the NPs were separated by relative pronouns such as *which* and *whom*, as illustrated in (9).

(9) The pen which the author whom the editor liked used was new.

(Fodor & Garrett, 1967, p. 291)

Fodor and Garrett argued that the presence of relative pronouns in 2-CE-RCs would make them more comprehensible since the relative pronouns provided a surface structure clue to the deep syntactic structure. They investigated this hypothesis through paraphrasing tasks where the participants paraphrased both auditorily and visually presented sentences such as (8) and (9). The results showed that 2-CE-RCs with relative pronouns as in (9) were better remembered than those without relative pronouns as in (8). Fodor and Garrett concluded that the use of relative pronouns informed the parser on the transitivity of the verbs, which, in turn, helped building the correct syntactic structure for the sentence. But later studies demonstrated that the use of relative pronouns did not indeed eliminate the processing difficulty in 2-CE-RC structures (e.g., Vasishth et al., 2010).

Fodor and Garrett (1967) also proposed that the processing difficulty in 2-CE-RCs was due to their structural density. That is, 2-CE-RCs are perceptually complex due to a low proportion of terminal nodes (i.e., words) to sentence nodes (i.e., clauses). This argument was based on the idea that syntactically flat structures with a higher number of terminal nodes are less complex than deeply embedded structures with fewer terminal nodes. The structural density of the 2-CE-RC in (10) would therefore be 9:3, 9 being the number of terminal nodes and 3 being the number of sentence nodes.

(10) [The rat [the cat [the dog chased] ate] died.]

(Chomsky & Miller, 1967, p. 286)

However, Kimball (1973) argued against this explanation and argued that sentences with even higher structural densities, such as (11) which has a density of 7:3 (7 being

the number of words, 3 being the number of sentence nodes), could be perceptually less complex.

(11) [That [she runs] proves] [that she walks].

(Kimball, 1973, p. 18)

He proposed that three of his seven language processing principles, (i) the principle of right association, (ii) the principle of new nodes and (iii) the principle of two sentences, can indeed account for the difficulty in 2-CE-RCs. The principle of right association maintains that right-branching structures are generally preferable to other structures. Since center-embedded structures do not right-branch, they are difficult to process. The principle of right association fails to explain the difficulty for 2-CE-RCs in left-branching languages such as Turkish or Japanese, though. The principle of new nodes maintains that the occurrence of a grammatical function word signals an upcoming new node and absence of such a cue, no relative pronouns in the case of 2-CE-RCs, increases their comprehension difficulty. Although the presence of relative pronouns was shown to eliminate a misleading coordination interpretation of subject NPs (Fodor & Garrett, 1967), later studies manipulating the use of relative pronouns showed that they did not eliminate the difficulty in processing 2-CE-RC structures (e.g., Vasishth et al., 2010). Lastly, the principle of two sentences states that "the constituents of no more than two sentences can be parsed at the same time"; the presence of a third clause in 2-CE-RCs would thus push the limits of the short-term memory (Kimball, 1973, p. 33). However, this explanation was later opposed with sentences including two levels of embeddings with sentential complements as in (12a) or even with relative clauses as in (12b), which do not cause the same processing difficulty as the sentences as in (10) above.

(12) a. That the food that John ordered tasted good pleased him.

b. What the woman that John married likes is smoked salmon.

(Lewis & Nakayama, 2002, p. 86)

Fodor, Garrett and Bever (1968) proposed that the number of possible syntactic configurations of a verb (e.g., verbs taking only NPs as a complement vs. verbs taking NPs or CPs as a complement) determined the difficulty of sentences including that verb. As the variety of possible syntactic configurations of the verb increases, the sentence becomes harder to parse. To exemplify, a verb such as *meet* has only one possible syntactic structure as it can only take an NP complement whereas a verb such as *know* can take either an NP or a CP complement. A sentence that contains *know* is, thus, predicted to be harder to process than a sentence that contains *meet*. Fodor et al. tested this prediction in two paraphrasing tasks with either visual or auditorial presentation of stimulus and an anagram task in which the participants were asked to construct sentences from a scrambled set of words. They compared pairs of 2-CE-RCs which included a verb permitting both an NP and a CP complement as in (13a) or a verb permitting only an NP complement as in (13b). They predicted that the sentences including verbs with a higher number of possible syntactic configurations such as *know* as in (13a) would be harder to process than those including verbs with less possible syntactic configurations such as *meet* as in (13b).

(13) a. [The box [the man [the child knew] carried] was empty.]

b. [The box [the man [the child met] carried] was empty.]

(Fodor et al., 1968, p. 455)

The results of these experiments confirmed their predictions in that 2-CE-RCs with *know* as in (13a) were harder to paraphrase or to construct than those with *meet* as in

(13b). These findings were taken as evidence to suggest that verbs are crucial in decoding sentences, and using structural properties of verbs can help the assignment of a correct structure to 2-CE-RC structures.

An alternative explanation proposed that the difficulty in center-embedded structures was due to stacked NPs, i.e., the consecutive occurrence of NPs, that are at the beginning of the sentence (Eady & Fodor, 1981; Mazuka et al., 1989). Two experimental studies were conducted to investigate the role of stacked NPs on center-embedding difficulty. Eady and Fodor (1981) conducted an on-line reading study to investigate whether the difficulty of center-embedded structures was dependent on the position of relative clauses and/or the number of stacked-NPs. Their experiment employed four conditions manipulating the number of stacked-NPs (three as in (14a-b) vs. two as in (14c-d)) and the position of RCs (RCs following the subjects of the clauses as in (14b, d) vs. the objects of the clauses as in (14a, c)).

(14) a. [The patient [the nurse [the clinic had hired] sent to the doctor]
NP1 NP2 NP3

met Jack.]

b. [Jack met the patient [the nurse [the clinic had hired] sent to the
NP1 NP2 NP3

doctor.]]

c. [The patient [the nurse sent to the doctor [the clinic had hired]]
NP1 NP2 NP3

met Jack.]

d. [Jack met the patient [the nurse sent to the doctor [the clinic
NP1 NP2 NP3

had hired.]]]

(Eady & Fodor, 1981, p. 13)

Eady and Fodor predicted that if increasing the number of stacked NPs caused enhanced processing difficulty, the sentences with three stacked NPs as in (14a-b) would be more difficult to process than those with two as in (14c-d).

The results showed that doubly center-embeddings with the RCs following the objects as in (14b, d) were easier to process than those with the RCs following the subjects as in (14a, c). And the sentences with three consecutive subject NPs as in (14a-b) were harder to process than sentences with two consecutive subject NPs as in (14c-d). Based on their results, Eady and Fodor proposed that there were two possible causes of center-embedding difficulty: (i) the existence of nested filler-gap dependencies and (ii) the stacking of three NPs.

Mazuka et al. (1989) conducted an eye-tracking experiment to examine whether the processing difficulty of Japanese center-embeddings was due to stacked-NPs or filler-gap dependencies. Japanese is an ideal language to tease apart these two possibilities because in Japanese, a head-final language, center-embedded structures can be formed with or without filler-gap dependencies (see Section 1 in Chapter 3 for further details on center-embedded structures in head-final languages). Their experimental stimuli included a set of five singly center-embedded sentences as in (15) and a set of five doubly center-embedded sentences as in (16). The number of stacked-NPs was kept constant in doubly center-embeddings, i.e., three stacked NPs, but in singly center-embeddings there were two stacked NPs in (15a-c) while there was no stacked NP in (15d-e). In singly center-embeddings, the number of filler-gap dependencies was zero in (15c), one in (15a, b, e) and two in (15d). In the doubly center-embedded sentences, the number of filler-gap dependencies was zero in (16d), one in (16a, e) and two in (16b, c).

(15) a. [Hirosi-ga [Masao-ga e katta] pan o tabeta]

'Hirosi ate the bread Masao bought.'

b. [Yuuji-ga [hahaoya-ga e kaita] memo o mituketa]

'Yuuji found a memo his mother wrote.'

c. [Hiromi-ga [Yuuko-ga kazeo hit] node mimai ni itta]

'Hiromi went to visit Yooko because she caught a cold.'

d. [e-Titioya-o [e-hahaoya-o keno siteiru] musuko ga tayotte kita.]

'The son who hated his mother came to his father for help.'

e. [e-Tanaka-ni [e-Suzuki ni e kiita] nyuusu o tsutaeta.]

'(I) told Tanaka the news I heard from Suzuki.'

(16) a. [Yoko-ga [Hiromi-ga [Asako-ga e-kaita] genkoo o kakinaosita] syroui o yonda.]

'Yoko read the papers that Hiromi re-wrote based on the draft Asako wrote.'

b. [Yuuko-ga [Akio-ga [Satoru-ga e-katte kita] mame o hiite e ireat] koohii o nonda.]

'Yuuko drank the coffee Asako made with the beans Satoru bought.'

c. [Yamaguti-ga [tuma-ga [titioya-ga e-nokosita] kabu o utte e tukutta] kane de ie o tateta.]

'Yamaguchi build a house with the money his wife made by selling the Stock her father left.'

d. [Akira-ga [Tosiko-ga [Hazime-ga nakidasita] toki okidasita] no no kizuita.]

'Akira noticed that Toshika got up when Hajime started crying.'

e. [Mayumi-ga [kodomo-ga [syuuto-ga e tukatte ita] yunomi o kowasite simatta] node e atarasiku katta kita.]
‘Mayumi bought a new teacup since the child broke the one her mother-in-law was using.’

(Mazuka et al., 1989, pp. 193-194)

Mazuka et al. predicted that if doubly center-embeddings were more difficult than singly center-embeddings, the sentences in (16) would take longer to read than those in (15). If stacked NPs were the reason of enhanced processing difficulty in doubly center-embedded structures, all the sentences in (16), regardless of their number of filler-gap dependencies, would take longer time to read than singly center-embeddings as in (15). For each sentence, two reading time measures were calculated: the reading time per character, i.e., total reading time for the sentence divided by the number of characters in the sentence, and the reading time per mora, i.e., total reading time for the sentence divided by the number of moras in the sentence.

The results showed that in both measures the doubly center-embedded sentences as in (16) took nearly twice as long to read as singly center-embedded sentences as in (15). This was the case when the doubly center-embeddings with one or no filler-gap dependencies were included. That is, the doubly center-embedded sentences were all more difficult to process than singly center-embedded sentences regardless of whether or not they included nested filler-gap dependencies. Mazuka et al., thus, argued that the difficulty of doubly center-embedded structures was due to stacked NPs, i.e., the consecutive occurrence of NPs, and the difficulty was independent of filler-gap dependencies. They proposed that center-embedding difficulty was due to the surface string of stacked NPs, rather than the assignment of

argument structure at a deeper level. This conclusion was based on their intuition that the doubly center-embedded structure became easier to process when one or two overt NPs at the beginning of the doubly center-embedded sentences in (16) were dropped, i.e., when they are null, decreasing the number of stacked-NPs.

Although the number of stacked NPs was found to be a source of difficulty in center-embedded structures by Eady and Fodor (1981) and Mazuka et al. (1989), Lewis (1996) argued that stacked NPs do not always cause difficulty, especially in head-final languages such as Japanese, in which sentences with five stacked NPs as in (17) may be acceptable. In (17), two of the stacked NPs were subject NPs, the other two were dative-marked object NPs and one was accusative-marked object NP.

(17) John-wa Bill-ni Mary-ga Sue-ni Bob-o
John-TOP Bill-DAT Mary-NOM Sue-DAT Bob-ACC
syookai sita to it-ta.
introduced SUB say PERF.
'John said to Bill that Mary introduced Bob to Sue.'

(Lewis, 1996, p. 104)

That is, although the sentence in (17) has five stacked NPs at the beginning of the sentence, it does not cause the same difficulty as the doubly center-embedded sentences with three stacked NPs as in (16). Lewis, thus, proposed in his interference-based account that the stacked NPs that cause the processing difficulty in center-embedded structures must have the same structural relations, e.g., they must all be subjects. The details of the interference-based account will be discussed in Section 2.3.

Another account on center-embedding difficulty attributed the difficulty to semantic/pragmatic similarity of the arguments in the sentence (Bever, 1970;

Hudson, 1996; Stolz, 1967; among others). This account opposes the structure-based accounts that have been outlined above in that it argues that the difficulty of center-embedded structures which are structurally the same could be modulated by semantic/pragmatic factors. In this account, 2-CE-RCs become easier to process when NPs are from distinct semantic classes, when VPs are differentiated from one another or when the links between the NPs and VPs were semantically distinguishable from others.

Bever (1970) argued, in non-experimental work, that when the NPs were from different semantic classes and their predicates were differentiated from one another, the processing of 2-CE-RCs became easier. For instance, Bever maintained that the 2-CE-RC in (18a), in which the second NP, *the distraction,* was inanimate whereas the first NP, *the dog,* and the third NP, *the wild fox,* were animate, and the VPs were each marked with different tenses, was more difficult to process than that in (18b), in which all the NPs belonged to the same semantic class of animate nouns and all the VPs were in the same past progressive form.

(18) a. [The dog [the distraction [the wild fox produced] was scaring] will run away fast.]

(Bever, 1970, p. 338)

b. [The dog [the cat [the fox was chasing] was scratching] was yelping.]

(Bever, 1970, p. 334)

Stolz (1967) conducted untimed paraphrasing tasks to test how semantic support between NPs and their predicates would influence processing 2-CE-RC structures in English. Stolz's experimental sentences manipulated the semantic

support of the sentences (semantically supported as in (19a) vs. semantically unsupported 2-CE-RCs as in (19b)).

(19) a. [The bees [that the hives [that the farmer built] housed] stung the children.]

b. [The chef [that the waiter [that the busboy appreciated] teased] admired good musicians.]

(Stolz, 1967, p. 870)

The results showed that the participants were more accurate in their paraphrases for the sentences with semantic support as in (19a) than those without semantic support as in (19b).

Gibson (1998), however, argued that the explanations that are based purely on semantic distinguishability would be insufficient to explain the processing difficulty of 2-CE-RCs mainly because the 2-CE-RCs with semantic distinguishability as in (18a) and (19a) are still extremely difficult to process. Gibson proposes instead that the difficulty in center-embedded sentences was due to working memory limitations. The details of Gibson's account will be presented in Section 2.1.

This section presented a summary of the earlier structure-based accounts of center-embedding difficulty, including their counter arguments, and if any, the experimental studies testing these accounts. These accounts attributed the extreme difficulty of center-embedded structures to the nesting of the same type of clauses (Babyonyshev & Gibson, 1995; Kuno, 1974; Yngve, 1960; among others), the number of incomplete syntactic dependencies (Chomsky & Miller 1963; Miller & Chomsky 1963; Miller & Isard 1964; Yngve 1960), double function of NPs (Bever, 1970), the consecutive occurrence of three NPs (Blumenthal, 1966), structural density (Fodor & Garrett, 1967), the presence of two incomplete sentences (Kimball,

1970), the lack of relative pronouns (Fodor et al., 1968; Kimball, 1970), the complexity of verbs (Fodor et al., 1968), the presence of filler-gap dependencies (Eady & Fodor, 1981), the number of stacked NPs (Eady & Fodor, 1981; Mazuka et al., 1989), semantic/pragmatic indistinguishability of the arguments in the sentence (Bever, 1970; Hudson, 1996; Stolz, 1967; among others).

The next section presents the resource-based accounts of center-embedding difficulty.

2.2 Resource-based account

Comprehending a sentence involves syntactic and semantic interpretation of a sequence of words, but (working) memory resources that also influence this process are limited. Resource-based accounts take such memory constraints into consideration in their approach to the center-embedding difficulty. Gibson (1998; 2000) proposed Syntactic Prediction Locality Theory (SPLT, Gibson, 1998), which he later revised as the Dependency Locality Theory (DLT, Gibson, 2000), and explained the processing difficulty associated with center-embeddings with reference to working memory limitations. This section presents Gibson's model based mainly on the assumptions of the SPLT. In the SPLT, Gibson argues for two components of sentence comprehension that consume memory resources: (i) integrating words into the current structure and (ii) storing the structure in the memory until it is integrated into the current sentence. The component for integrations is referred to as *integration cost,* and it is quantified in terms of Energy Units (EUs). The component of storing the structure in memory is referred to as *memory (storage) cost,* and it is quantified in terms of Memory Units (MUs).

In the SPLT, sentence complexity is explained with integration cost and memory cost. In *integration cost*, resources that are required to integrate a new syntactic head into the current structure depend on the distance between the new head and its dependent in the current structure. The integration cost is quantified by the number of new discourse referents (an NP referring to a new referent or a VP referring to a new event referent) separating the new head and its dependent. That is, the integration cost increases with new discourse referents, but not with old discourse referents that are already present in the discourse such as first- or second-person pronouns. This is because much computational effort is involved in building a structure for a new discourse referent, which results in higher integration cost for new discourse referents. In *memory cost*, each syntactic head that is needed to be kept in memory to complete the current string of words as a grammatical sentence is associated with a memory cost. As an exception, it is assumed that there is no memory cost in predicting the matrix verb because the parser predicts a verb in most utterances, which leads the parser to usually expect a predicate with no additional memory cost. Similar to the integration cost, the memory cost for each predicted syntactic head increases as new discourse referents are processed. The total memory cost for a given word is equal to the costs for all the required syntactic heads at that point in the sentence. Both integration cost and memory cost are locality-based, meaning that longer distance head-dependent integrations are more costly than shorter distance head-dependent integrations; and syntactic predictions that are held in memory over longer distances are more expensive than those that are kept in memory over shorter distances. The SPLT maintains that integration cost and memory cost access the same pool of computational resources.

Gibson claims that the comprehension difficulty at a word is assumed to be mainly determined by five factors: (i) the frequency of the lexical items to be integrated, (ii) the contextual plausibility of the final structure, (iii) the structural integration cost at a given word, (iv) the memory cost at a given word and (v) the discourse complexity of the final structure. The first two factors do not differ to a significant amount in general, thus Gibson concentrates on the last three, namely structural integration, memory cost and discourse complexity because the combination of the factors appear to explain processing difficulties in a number of structures across languages such as ambiguity resolution, length/heaviness effects, subject vs. object relative clauses and center-embedded sentences. In the rest of this section, the focus will be on the SPLT's explanations for center-embedding difficulty.

The SPLT suggests that the difficulty in processing center-embedded structures is due to the high amount of resources that is required in their processing. In the SPLT center-embedding difficulty is mainly explained in terms of MUs of the memory cost. For a 2-CE-RC sentence as in (20) below, the SPLT predicts the point of maximal *memory* complexity to be at NP3, *the nurse,* where there are five predicted syntactic heads, resulting in 6 MUs.

(20) [The administrator [$_{RC1}$ who the intern [$_{RC2}$ who the nurse supervised]
NP1 NP2 NP3 VP3

had bothered] met Jack.]
VP2 VP1

(Gibson, 1998, p. 34)

The predicted heads and their associated memory costs at the point of NP3, *the nurse,* are as follows:

1. the prediction of a matrix verb for NP1, *the administrator* (which involves no cost (=0 MU)[2],
2. the prediction of a verb for RC1, which costs 2 MUs because two discourse referents, namely NP2, *the intern,* and NP3, *the nurse,* have been processed since the prediction was first made,
3. the prediction of an empty category to be co-indexed with the first RC pronoun *who,* which costs 2 MUs because of two discourse referents, namely NP2, *the intern,* and NP3, *the nurse,* have been processed since the prediction was first made,
4. the prediction of a verb for RC2, which costs 1 MU because one discourse referent, namely NP3, *the nurse,* has been processed since the prediction was first made,
5. the prediction of an empty category to be co-indexed with the second RC pronoun *who,* which costs 1 MU because one discourse referent, namely NP3, *the nurse,* has been processed since the prediction was first made.

In the sentence in (20), the point of maximal *integration* complexity is at VP2, *had bothered,* where there are two long integrations to be performed: (i) assigning a thematic role from VP2 to its subject NP2 and associating the empty object category of VP2 with the second RC pronoun *who.*

Based on the SPLT, Gibson and Thomas (1999) proposed *the high memory cost pruning hypothesis* to explain missing-VP illusion in 2-CE-RCs. Recall Frazier's (1985) observation that the omission of the second verb, VP2, from 2-CE-RC structures would go unnoticed, and the ungrammatical sentence with a missing VP2 as in (21b) would be perceived to be grammatical.

[2] The assumption that there is no memory cost for the predicate of the matrix clause was omitted in the later version of the theory, the DLT (Gibson, 2000).

(21) a. [The patient [$_{RC1}$who the nurse [$_{RC2}$who the clinic] had hired]
NP1 NP2 NP3 VP3

admitted] met Jack.]
VP2 VP1

b. [The patient [$_{RC1}$who the nurse [$_{RC2}$who the clinic] had hired]
NP1 NP2 NP3 VP3

~~admitted~~] met Jack.
VP2 VP1

(Frazier, 1978, p. 178)

Gibson and Thomas's (1999) high memory cost pruning hypothesis maintains that "at points of high memory complexity, [the parser may] forget the syntactic prediction(s) associated with the most memory load" (Gibson & Thomas, 1999, p. 231). That is, when the parser reaches a limit where it has run out of its computational resources, it may tend to forget some parts of the structure that is built thus far to free some of its resources for processing the rest of the sentence. The point of maximal memory cost in the 2-CE-RC structure in (21a) would be the NP3, *the clinic*. The predictions with the highest memory cost (=4 MUs) at this point are the predictions of RC1: (i) the prediction of VP2 for RC1, which costs 2 MUs and (ii) the prediction of an empty category to be co-indexed with the first RC pronoun *who,* which costs 2 MUs. Both of these predictions would be associated with the second verb, VP2, *admitted*. Thus, upon processing NP3, *the clinic*, the predictions regarding VP2, *admitted,* would be forgotten. In the sentence in (21b), in which VP2, *admitted,* is omitted, as the prediction of VP2 would already be forgotten, the parser would not notice the lack of VP2 and would perceive the sentence as grammatical. That is, the parser would have a grammaticality illusion in the case of a missing-VP2

as VP2 is the verb phrase with the most expensive memory predictions and is forgotten due to memory overload[3].

The predictions of the SPLT (or its later version, the DLT) were tested in experiments that examined the processing difficulty associated with center-embedded structures in Japanese (e.g., Babyonyshev & Gibson, 1999; Nakatani & Gibson, 2010) and in English (Warren & Gibson, 2002; for English). The predictions of the model for missing-VP2 illusion were also tested (Gibson & Thomas, 1999; Gimenes et al., 2009). Since the present study tests the predictions of the SPLT only for missing-VP2 illusion, in the following I report on only the studies that investigated missing-VP2 illusion.

Gibson and Thomas (1999) investigated (i) whether or not there was missing-VP illusion in English as was noted by Frazier (1978) and (ii) if there was missing-VP illusion in English, which VP, i.e., VP1, VP2 or VP3, would be forgotten. There were four conditions manipulating the grammaticality of the sentences (grammatical with all three VPs present as in (22a), ungrammatical due to a missing VP3, *had confused a great deal*, as in (22b), ungrammatical due to a missing VP2, *was studying in the library*, as in (22c) or ungrammatical due to a missing VP1, *was missing a page,* as in (22d)).

(22) a. [The ancient manuscript [that the graduate student
NP1 NP2

[who the new card catalog had confused a great deal] was studying
NP3 VP3 VP2

in the library] was missing a page.]
VP1

[3] Note that in the DLT (Gibson, 2000) VP2 has the highest integration cost and thus, its omission results in the largest reduction in the overall integration cost of the sentence (see Vasishth et al., 2010, pp. 534-537 for a detailed discussion on the differences in the predicitons of SPLT and DLT for missing-VP2 illusion).

b. The ancient manuscript that the graduate student who the new card catalog ~~had confused a great deal~~ was studying in the library was missing a page.

c. The ancient manuscript that the graduate student who the new card catalog had confused a great deal ~~was studying in the library~~ was missing a page.

d. The ancient manuscript that the graduate student who the new card catalog had confused a great deal was studying in the library ~~was missing a page~~.

(Gibson & Thomas, 1999, p. 237)

Under the high memory cost pruning hypothesis, Gibson and Thomas estimated that due to high memory overload the predictions associated with VP2 would be forgotten and thus, the sentence in (22c) in which VP2 was omitted would receive the highest ratings among the three ungrammatical conditions. Note that under this hypothesis, the sentences with a missing VP2 as in (22c) are predicted to be rated even higher than the grammatical sentences which have all the VPs present as in (22a). The reason is that the omission of VP2 would decrease the overall memory cost of the sentence, and lead to an easier processing in sentences with a missing VP2 compared to their grammatical versions. These predictions were tested in an off-line comprehensibility rating questionnaire.

The results of the questionnaire indicated that the sentences with a missing VP2 as in (22c) received the highest ratings among all three missing conditions, but there was no reliable difference between the ratings for the sentences with a missing VP2 as in (22c) and the grammatical sentences with all three VPs as in (22a). Thus, as predicted by the SPLT, in processing center-embedded structures the predictions

for VP2 were forgotten, resulting in a grammaticality illusion in its absence. These findings were the first empirical evidence for missing-VP2 illusion in English. However, the results did not confirm the prediction that sentences with a missing VP2 would be less complex and thus, receive higher ratings than their grammatical versions. Gibson and Thomas suggested that this could be due to the off-line nature of the task. That is, although the participants were told to read the sentences only once, the off-line task might have led the participants to re-read the sentences and to check whether the subject NPs were licensed by the verbs that followed them. This could have allowed them to notice the omission of VP2, decreasing the ratings for the sentences with a missing VP2.

Gimenes et al. (2009) conducted a non-cumulative self-paced reading task followed by acceptability ratings to investigate missing-VP2 illusion in French. They tested whether or not missing-VP2 illusion that was observed in English center-embeddings (Gibson & Thomas, 1999) would also be present in French 2-CE-RCs. They employed two conditions manipulating the grammaticality of the sentence (grammatical with all three VPs present or ungrammatical due to a missing VP2, *a goûté dans le nouveau restaurant* (tasted in the new restaurant), which is shown in italic in (23a)). Gimenes et al. argued that the null results regarding the difference between grammatical sentences and ungrammatical sentences with a missing VP2 in Gibson and Thomas' (1999) study could be due to the possibility that the participants completely neglected VP2 and only checked whether the first and the third subjects had their verbs. To force the participants to pay attention to VP2, Gimenes et al. included comprehension questions which asked about subject-verb relations for either the second or the third subject in the sentence, as exemplified in (23b).

(23) a. Le plat mexicain que le critique culinaire que le magazine a engagé *a goûté dans le nouveau restaurant* avait une odeur étrange.

'The Mexican meal restaurant that the gastronomic critic that the journal hired tasted in the new restaurant had a strong smell.'

b. *NP2 Question:* Qu'a fait le critique?

'What did the critic do?'

NP3 Question: Qu'a fait le magazine?

'What did the journal do?'

(Gimenes et al., 2009, p. 444)

Based on Gibson and Thomas' (1999) high memory cost pruning hypothesis, Gimenes et al. predicted that the ungrammatical condition with a missing VP2 would receive higher ratings than their grammatical version.

The rating data showed that the ungrammatical condition with a missing VP2 received higher ratings than the grammatical condition with all three VPs present. Thus, unlike the findings of Gibson and Thomas, Gimenes et al.'s study showed evidence for an easier processing of French center-embeddings with a missing VP2 compared to their grammatical versions. Gimenes et al. argued that whereas the off-line nature of the task in Gibson and Thomas' study may have enabled the participants to re-read the sentences and possibly notice the omission of VP2, the word-by-word on-line reading task in their study eliminated the possibility of re-reading and thus, allowed to show the predicted difference between missing-VP2 and grammatical conditions. For comprehension questions, the percentage of correct answers in the ungrammatical sentences with a missing VP2 was 49% for NP2 and 63% for NP3, and the percentage of correct answers in the grammatical sentences was 68% for NP2 and 64% for NP3. Gimenes et al. argued that the participants

correctly answered the questions about NP2 in the ungrammatical sentences in approximately half of the cases (49%), suggesting that they were able to infer VP2 when it was missing.

The analyses for the reading time (RT) data showed that the RTs for the final VP, *avait une odeur étrange* (had a strong smell), in the grammatical condition were shorter than those in the ungrammatical condition. This would suggest that unlike the findings of the acceptability ratings, the participants had an on-line sensitivity to missing VP2 in the ungrammatical sentences. Gimenes et al. suggested three explanations for this on-line sensitivity: (i) a simple position effect, i.e., later segments (e.g., VP1 in the grammatical sentences which occurs after two verbs) were read faster than earlier segments (e.g., VP1 in sentences with a missing VP2 which occurs after only one verb), (ii) a true on-line sensitivity to a missing VP2, which did not influence the off-line ratings, and (iii) an increased processing difficulty due to the presence of two subject NP candidates, namely NP1 and NP2, upon processing VP1 in the ungrammatical sentences as opposed to one subject NP candidate in the grammatical sentences. Overall, Gimenes et al. concluded that their findings presented evidence for missing-VP2 illusion in French 2-CE-RCs, and confirmed Gibson and Thomas' (1999) prediction that ungrammatical sentences with a missing VP2 were easier to process than their grammatical versions.

Next, I discuss the experience-based accounts for missing-VP2 illusion.

2.3 Experience-based accounts

This section reviews the experience-based accounts and their predictions for missing-VP2 illusion. The studies on center-embedding difficulty tested the predictions of the experience-based accounts only with regard to missing-VP2 illusion. None of those

studies, to my knowledge, specifically investigated the processing difficulty associated with center-embedding structures.

Recall from Section 2.2 that in the resource-based accounts missing-VP2 illusion is attributed to forgetting the predictions for the second verb, which is associated with the highest memory load in the sentence (Gibson & Thomas, 1999). The resource-based accounts would therefore predict the illusion to appear cross-linguistically presumably because in these accounts the human parsing mechanism is mostly defined to be universal and the constraints that it encounters would apply to all languages. The experience-based accounts, on the other hand, maintain that experience with language-specific properties may modulate the presence of missing-VP2 illusion (Frank & Ernst, 2018; Frank et al., 2016; Vasishth et al., 2010). That is, in the experience-based accounts whether or not there is missing-VP2 illusion in a language depends on experience with a priori grammatical constraints, such as verb-finality or punctuation rules, in that language.

Two different views on the role of experience on missing-VP2 illusion have been proposed. The first view is by Vasishth and colleagues (Vasishth et al., 2010), and it maintains that the ability to keep the predictions for VP2 in working memory depends on the grammatical properties of the language under investigation. That is, unlike the speakers of languages with few (or no) verb-final structures, e.g., English or French, the speakers of languages with verb-final structures, e.g., German, Dutch, Hindi or Turkish, have more robust working memory predictions for VP2, and hence, are less susceptible to missing-VP2 illusion. This is because in languages with verb-final structures, predicting upcoming verbs is a more frequent requirement and leads to better working memory representations for predicted verbs. Having better working memory representations for predicted verbs, in turn, would allow the

speakers of those languages to better detect the absence of a verb in the sentence (i.e., reduced susceptibility to missing VP2 illusion).

The second view, by Frank and colleagues (Frank & Ernst, 2018; Frank et al., 2016), relates missing-VP2 illusion to language statistics, such as the frequency of verb-final structures in the language, rather than language users' working memory predictions for VPs. In this view, whereas it is less likely to have a three-verb sequence in verb-initial languages such as English and French; in verb-final languages such as German, Dutch, Hindi and Turkish such sequences are more likely. Hence, in verb-final languages the absence of a third verb would be less likely to go unnoticed compared to verb-initial languages. Next, I present the studies that investigated the presence or absence of the missing-VP2 illusion in relation to the experience-based accounts.

Christiansen and MacDonald (2009) conducted two experiments to investigate missing-VP2 illusion in English 2-CE-RCs. Both experiments used stop-making-sense grammaticality judgments. Experiment 1 employed two conditions manipulating the grammaticality of the sentences (grammatical vs. ungrammatical due to a missing VP2, *was cleaning every week*, which is in italic in (24)).

(24) The apartment that the maid who the service had sent over *was cleaning every week* was well decorated.

(Christiansen & MacDonald, 2009, p. 144-145)

The experimental stimuli in Experiment 1 had semantic support between the subjects and their verbs, i.e., subject and their verbs allowed for apparent semantic relations between agents, patients and actions (e.g., *the apartment is decorated*, *the maid cleans* and *the service is sent over* in the sentence in (24)). The results of Experiment

1 showed higher ratings for the ungrammatical condition with a missing VP2 than the grammatical condition.

Christiansen and MacDonald conducted another experiment (Experiment 2) to test whether or not missing-VP2 illusion would be present in English 2-CE-RCs (i) when there was no semantic support between the subjects and their verbs and (ii) when the overall sentence length was controlled between the grammatical and ungrammatical conditions. Similar to Experiment 1, Experiment 2 had two conditions manipulating the grammaticality of the sentences (grammatical with all three VPs present vs. ungrammatical due to a missing VP2, *appreciated,* which is shown in italic in (25)). In the ungrammatical conditions, an adverb, given in parentheses in (25), replaced the omitted VP2 to control for overall sentence length across the grammatical and ungrammatical conditions. Unlike in Experiment 1, there was no semantic support between the subjects and their verbs in the materials.

(25) The chef who the waiter who the busboy offended *appreciated* (frequently) admired the musicians.

(Christiansen & MacDonald, 2009, p. 147)

Similar to the results from Experiment 1, the ungrammatical sentences with a missing VP2 received higher ratings than their grammatical versions. Overall, Christiansen and MacDonald claimed that higher ratings for the ungrammatical sentences than their grammatical versions showed evidence for missing-VP2 illusion in English, and they attributed the presence of illusion to constraints in processing English 2-CE-RCs that result from limited experience with those structures.

Vasishth et al. (2010) examined whether or not missing-VP2 illusion existed in 2-CE-RCs in English and German. They specifically tested (i) whether or not missing-VP2 illusion in English 2-CE-RCs reported in off-line measures, such as

judgment tasks (Christiansen & MacDonald, 2009; Gibson & Thomas, 1999), would also be observed in on-line measures such as self-paced reading and eye-tracking, and (ii) whether or not missing-VP2 illusion was a cross-linguistic matter that applied to languages with different headedness properties (e.g., German with verb-final structures in subordinate clauses vs. English as a strict verb-initial language). To test these questions, Vasishth et al. conducted seven experiments, five of which employed self-paced reading tasks and two of them employed eye-tracking methodology.

Experiments 1 and 2 investigated the missing-VP2 illusion in English 2-CE-RCs. Experiment 1 was a self-paced reading and Experiment 2 was an eye-tracking experiment. In both experiments, there were two conditions which manipulated the grammaticality of the sentences (grammatical with all three VPs present vs. ungrammatical due to a missing VP2, *hurt,* which is in italic in (26)).

(26) The carpenter who the craftsman that the peasant carried *hurt* supervised the apprentice.

(Vasishth et al., 2010, p. 539)

Vasishth et al. (2010) predicted that if missing-VP2 illusion existed in English 2-CE-RCs in on-line measures, the RTs at the final verb and the word following that, the spill-over region, would be shorter in the ungrammatical condition than in the grammatical condition because the omission of VP2 would decrease the total integration cost of the sentence (cf. Gimenes et al. (2009) (Section 2.2) who demonstrated longer RTs in the ungrammatical conditions for missing-VP2 illusion in French). For Experiment 2 and all the other eye-tracking experiments, Vasishth et al. reported only the re-reading times (RRT) measure.

In line with these predictions, the results of Experiments 1 and 2 revealed shorter RTs at the final verb and the spillover region in the ungrammatical condition than in the grammatical condition. These results confirmed missing-VP2 illusion in English 2-CE-RCs with on-line measures.

However, Vasishth et al. speculated that the observed difference between the grammatical and ungrammatical conditions in Experiment 1 could also be attributed to the presence of three consecutive VPs in the grammatical conditions. More specifically, the occurrence of three consecutive VPs in the grammatical condition could have added extra processing difficulty to the sentences, which might have led to increased RTs in the grammatical condition. In order to test this prediction, they conducted a follow-up self-paced reading experiment, Experiment 1a, in which the presence of three consecutive VPs were interrupted by additional words in between the VPs. Experiment 1a employed the same two conditions, i.e., grammatical with all three VPs present vs. ungrammatical due to a missing VP2, *had hurt yesterday*, which is in italic in (27)).

(27) The carpenter who the craftsman that the peasant had carried to the bus stop *had hurt yesterday* supervised the apprentice.

(Vasishth et al., 2010, p. 544)

The results of Experiment 1a were consistent with Experiment 1, and the RTs at the final verb and the spill-over region were shorter in the ungrammatical condition than in the grammatical condition. Thus, the results of Experiment 1a confirmed that the observed difference between the grammatical and ungrammatical conditions in Experiments 1 and 2 was due to missing-VP2 illusion rather than the extra difficulty posed by the presence of three consecutive VPs.

Experiments 3 and 4 employed German 2-CE-RCs. The question was whether or not the missing-VP2 illusion that was observed in English 2-CE-RCs would also be present in German, a language with different word order properties than English. Unlike English which is a verb-initial language, German is verb-final in subordinate clauses. As in the previous experiments, these experiments employed two conditions manipulating the grammaticality of the sentence (grammatical with all three VPs present vs. ungrammatical due to a missing VP2, *schnitt* (surprised), which is in italic in (28).

(28) Der Anwalt, den der Zeuge, den der Spion betrachtete, *schnitt*, überzeugte den Richter.

'The lawyer who the witness who the spy looked at surprised convinced the judge.'

(Vasishth et al., 2010, p. 550)

The prediction was that if there was missing-VP2 illusion in German 2-CE-RCs as in English, the RTs in the ungrammatical condition would be shorter than the grammatical condition. But the results showed the opposite: the RTs at the final verb and the spill-over region were longer in the ungrammatical condition than in the grammatical condition. These results were inconsistent with the predictions of the resource-based accounts, and demonstrated that unlike in English, the predictions of VP2 were not forgotten in German.

One potential reason for the contrastive results observed in Experiments 1 and 2 on English and Experiments 3 and 4 on German could be the use of commas in German RCs. In German it is obligatory to use commas after the verbs in RCs while matrix verbs do not require commas. The use of commas after the verbs in RCs is an indication that the RC has ended. Thus, commas in German RCs may have provided

extra cues in processing German 2-CE-RCs such that German speakers may count the commas to build syntactic dependencies between the subjects and their verbs, which might, in turn, help them detect the missing VP2s. Vasishth et al. conducted two more self-paced reading experiments, Experiments 5 and 6, in which they added commas in English 2-CE-RCs. Experiment 5 was conducted to investigate whether the use of commas in English 2-CE-RCs would ease the detection of missing VP2 as they might have in German 2-CE-RCs. The conditions were similar otherwise: grammatical with all three VPs present vs. ungrammatical due to a missing VP2, *hurt*, which is in italic in (29).

(29) The carpenter, who the craftsman, that the peasant carried, *hurt*, supervised the apprentice.

(Vasishth et al., 2010, p. 554)

The results were the same as those for Experiments 1 and 2: the RTs at the final verb and the spill-over region were shorter in the ungrammatical condition than in the grammatical condition. These results confirmed that there was missing-VP2 illusion in English 2-CE-RCs regardless of the use of commas.

Vasishth et al. pointed out that the use of commas before an RC beginning with *that* in Experiments 5 could be objected since in English commas are only used with non-restrictive RCs. To address this objection, they conducted Experiment 6, in which *that* in the items of Experiment 5 was replaced with *who*. Similar to the results of Experiments 1, 2 and 5, the results of Experiment 6 demonstrated that the RTs at the spill-over region were shorter in the ungrammatical condition than in the grammatical condition. Hence, the results of Experiments 5 and 6 provided evidence that the presence of commas did not ease the processing of English 2-CE-RCs and the detection of missing VP2.

Overall, Vasishth et al. showed, in seven experiments, that missing-VP2 illusion existed in English not only in off-line processing (Gibson & Thomas, 1999; Christiansen & MacDonald, 2009), but also in on-line processing. Vasishth et al.'s results also showed that there was no missing-VP2 illusion in German 2-CE-RCs, which provided counter-evidence for the universality of missing-VP2 illusion. Vasishth et al. attributed these findings to the difference in the word order of German and English and the obligatory use of commas in German. Whereas English is a verb-initial language, German is verb-final in subordinate clauses. Vasishth et al. argued that since German speakers have more experience with verb-final structures, they may have more robust memory predictions for the upcoming verbs than English speakers. Moreover, whereas it is obligatory to use commas in German RCs, it is not in English RCs. The use of commas in German RCs may help German speakers detect the missing VP2. For these reasons, German speakers might be less susceptible to forgetting the predictions of VP2 than English speakers. Hence, Vasishth et al. concluded that missing-VP2 illusion was not a cross-linguistic phenomenon; rather, it was modulated by experience with language-specific properties such as verb-finality and punctuational differences.

Frank et al. (2016) investigated missing-VP2 illusion in Dutch as a first language and in English as a second language by Dutch and German speakers. Dutch and German are similar in terms of being verb-final in subordinate clauses; but, unlike German, Dutch does not require an obligatory use of commas with RCs. Frank et al. tested (i) whether or not missing-VP2 illusion would also be absent in Dutch, and (ii) whether or not German and Dutch native speakers would have missing-VP2 illusion when tested in their second language, English. The experiments addressing the second question are not reported here since the focus of the present

study is first language processing of (missing VP2 in) center-embedded structures. They conducted a word-by-word self-paced reading experiment to examine the first question.

Experiment 1 tested missing-VP2 illusion in Dutch 2-CE-RCs. The experimental items manipulated the grammaticality of the sentences (grammatical with all three VPs present vs. ungrammatical due to a missing VP2, *beangstigde* (frightened), which is in italic in (30)).

(30) De moeder die vrijdag de dochter die toen de zus
The mother who Friday the daughter who then the sister
vond *beangstigde* begroette de oma op de driewieler.
found frightened greeted the granny on the tricycle
'The mother who on Friday frightened the daughter who then found the sister greeted the granny on the tricycle.'

(Frank et al., 2016, p. 557)

Frank et al. predicted that if there was no missing-VP2 illusion in Dutch as in the case of German (Vasishth et al., 2010), the RTs at the final verb or the following word, i.e., spill-over region, would be shorter in the grammatical condition than in the ungrammatical condition. The results demonstrated that the spill-over region took shorter to read in the grammatical condition than in the ungrammatical condition, providing evidence that there was no missing-VP2 illusion in Dutch.

Frank et al. revealed that similar to German (Vasishth et al., 2010), Dutch did not have missing-VP2 illusion, which provided further support to the non-universality of the missing VP illusion. Furthermore, unlike German 2-CE-RCs in which the use of commas is obligatory in RCs (Vasishth et al., 2010), Dutch 2-CE-RCs do not require the use of commas. That is, Frank et al.'s results can only be

attributed to the word order differences in the languages. Frank et al.'s interpretations of their findings were different from Vasishth et al.'s interpretations, though. Frank et al. suggested that the reversal of the illusion in Dutch was due to the differences in language statistics, i.e., frequency of verb-final structures, rather than the differences in working memory predictions for upcoming verbs. This was mainly because the results of their L2 experiments showed sensitivity to word order statistics of the languages (German and Dutch second language speakers of English, similar to native speakers of English, had missing VP2 illusion in English.). The language statistics indicate that whereas it is less likely to have a three-verb sequence in verb-initial languages such as English, it is more likely to encounter them in verb-final languages such as German and Dutch. This would make it less likely for the language user to not notice a missing second verb in a verb-final language.

Frank and Ernst (2018) tested missing-VP2 illusion in Dutch and English 2-CE-RCs via three on-line judgment tasks. One of the experiments addressed missing-VP2 illusion in the second language, and this experiment is not reported here since the focus of the present study is first language processing of (missing VP2 in) center-embedded structures. In the experimental stimuli of the experiments, subjects and their verbs semantically supported each other through relations between agents, patients and actions. There were two reasons to have semantic support: (i) to ensure that missing-VP2 illusion was attributable to missing VP2 but not to missing VP1 or VP3 (without semantic relationship between subjects and their verbs, it was not clear if the illusion was truly due to missing VP2 or other VPs) and (ii) to control for word-order differences because without semantic support, and therefore semantic cues, the only cue to parsing was syntactic (i.e., word-order-related) cues; with

semantic support, semantic cues could override syntactic cues and word-order (i.e., headedness) differences could disappear.

Experiment 1 tested missing-VP2 illusion in Dutch, employing four conditions which manipulated the grammaticality of the sentences (grammatical with all the VPs present, ungrammatical due to a missing VP1, *miste een aantal pagina's* (was missing a number of pages), ungrammatical due to a missing VP2, *met veel vertrouwen publiceerde* (very confidently published) or ungrammatical due to a missing VP3, *nauwlettend bekritiseerden* (meticulously criticized)) as illustrated in (31).

(31) Het spannende boek dat de populaire schrijver die de recensenten nauwlettend bekritiseerden met veel vertrouwen publiceerde
VP3 VP2
miste een aantal pagina's.
VP1
'The exciting book that the popular author who the reviewers meticulously criticized very confidently published was missing a number of pages.'

(Frank & Ernst, 2018, p. 3)

The participants took part in a judgment task in which they would rate the comprehensibility and acceptability of sentences on two different scales for comprehensibility and acceptability. Frank and Ernst predicted that if there was no missing-VP2 illusion in Dutch, the grammatical condition would receive higher ratings than the ungrammatical conditions. The results showed that the grammatical sentences had higher ratings than all the three ungrammatical conditions, which provided further evidence for a lack of missing-VP2 illusion in Dutch when

participants were tested in an on-line judgment task and when there was semantic support between the subjects and their verbs.

Experiment 2 employed the same task as in Experiment 1 and the same four conditions as in Experiment 1, but the study language was English, and the materials were translated from Dutch to English. The results replicated previous findings on English (Christiansen & MacDonald, 2009) in that the ungrammatical condition with a missing VP2 had higher ratings than the grammatical condition. The ratings on the ungrammatical sentences with a missing VP1 or VP3 were identical to those on the grammatical sentences. Thus, this experiment showed evidence for missing-VP2 illusion in English when participants were tested in an on-line judgment task and when there was semantic support between the subjects and their verbs.

Overall, Frank and Ernst attributed the difference regarding the presence of missing-VP2 illusion between Dutch and English to a hybrid account of language statistics (Frank et al., 2016) and working memory explanations (Häussler & Bader, 2015; see Section 2.4.2 for details). Since primacy and recency effects lead to stronger working memory activation for the first and last subject NPs, the omission of their VPs is easily detected, leading to an absence of illusion in the case of missing VP1 and VP3. For the contrastive findings regarding the presence of illusion in the case of a missing VP2, they argued that due to the presence of verb-final subordinate clauses in Dutch, the occurrence of three verbs were more common in Dutch than in verb-initial languages such as English, which would make it less likely for Dutch speakers to not notice a missing VP2.

Husain and Bhatia (2018) conducted a self-paced reading experiment to investigate missing-VP2 illusion in 2-CE-RCs in Hindi, a head-final language. The experiment employed two conditions, manipulating the grammaticality of the

sentences (grammatical with all three VPs vs. ungrammatical due to a missing VP2, *dekh raha tha* (was seeing), which is italic in (32)).

(32) vah dhobi jo us doctor ko jo mariiz se paise le rahaa tha *dekh raha tha* gussa kar raha tha magar baad me uskaa gussaa kam ho gaya.
'That washerman was angry who was seeing the doctor who was taking the money from the patient, but later on his anger died down.'

(Husain & Bhatia, 2018)

The results indicated that the final verb took longer time to read in the ungrammatical condition than in the grammatical condition, which they took as evidence for the lack of missing-VP2 illusion in Hindi. Husain and Bhatia argued that the lack of missing-VP2 illusion in Hindi center-embeddings confirmed the predictions of the experience-based accounts; Hindi speakers were not susceptible to forgetting the verb predictions due to the head-finality of Hindi, and when VP2 was missing, their detection of it resulted in increased RTs. They further argued that this observation could indicate two possibilities for noticing the lack of a missing VP2: (i) the parser makes correct structural integrations or (ii) it uses a surface cue, i.e., relative pronouns, to count the number of upcoming verbs. The participants' accuracy on the comprehension questions showed that only 33% of the participants had 70% comprehension accuracy. This low accuracy was taken as evidence for a shallow parsing strategy in which the parser is more likely to rely on surface cues such as relative pronouns rather than performing complex structural integrations.

The experience-based accounts and their predictions for missing-VP2 illusion in a language were also tested in a number of studies through various computational models. Some of these studies used a neural network model, Simple Recurrent Network (SRN) (Christiansen & MacDonald, 2009; Engelmann & Vasishth, 2009;

Frank et al., 2016) while others employed non-neural computational models (Futrell & Levy, 2017; Futrell et al., 2020; Huang & Phillips, 2020). These models have all showed good predictive power. Whereas these models predicted missing-VP2 illusion for English (Christiansen & MacDonald, 2009; Engelmann & Vasishth, 2009; Frank et al., 2016; Futrell & Levy, 2017; Futrell et al., 2020) and Mandarin (Huang & Phillips, 2020), they predicted a lack of illusion for German (Engelmann & Vasishth, 2009; Futrell & Levy, 2017; Futrell et al., 2020; Huang & Phillips, 2020) and Dutch (Frank et al., 2016; Huang & Phillips, 2020). Most of the predictions of these models were in line with the experimental findings on these languages (but see Section 2.4.2 for Huang and Phillips (2020) on Mandarin and Bader and colleagues (Bader, 2015; Haussler & Bader, 2015) on German for contrastive empirical findings).

The studies discussed in this section showed that missing-VP2 illusion is not a universal phenomenon as was previously considered (cf. the resource-based account by Gibson & Thomas, 1999). These studies showed that either the grammatical (verb-initial or verb-final) or punctuational properties (Vasishth et al., 2010) or the statistical frequencies in a language (existence of consecutive verbs) (Frank & Ernst, 2018; Frank et al., 2016) may determine whether or not missing-VP2 illusion exists in that language. More specifically, it appears that verb-initial languages such as English and French show missing-VP2 illusion (Christiansen & MacDonald, 2009; Engelmann & Vasishth, 2009; Frank & Ernst; 2018; Frank et al., 2016; Futrell & Levy, 2017; Futrell et al., 2020; Gibson & Thomas, 1999; Huang & Philips, 2020; Vasishth et al., 2010 for English; Gimenes et al., 2009 for French), but languages employing verb-final structures such as German, Dutch and Hindi do not (Engelmann & Vasishth, 2009; Huang & Philips, 2020; Vasishth et al., 2010 for

German; and Frank & Ernst, 2018; Frank et al., 2016; Huang & Philips, 2020 for Dutch; Husain & Bhatia, 2018 for Hindi). The experience-based accounts, therefore, maintain that missing-VP2 illusion is a language-dependent phenomenon, and it may be modulated by language-specific properties such as word-order parameters and perhaps also punctuation rules (Frank & Ernst, 2018; Frank et al., 2016; Vasishth et al., 2010).

The present study investigates missing-VP2 illusion in Turkish center-embeddings (Experiments 1 and 2; see Chapter 3 for details). Turkish is a head-final language, which has verb-final structures in both matrix and subordinate clauses, unlike Dutch and German which are verb-final only in subordinate clauses. The experience-based accounts would predict no illusion in Turkish 2-CE-RCs when a VP is missing. The relatively stricter head-final property of Turkish would allow for a good testing ground for the predictions of the experience-based accounts and the universality of missing-VP2 illusion. Note that the lack of illusion in German 2-CE-RCs was also attributed to the obligatory use of commas in German RCs (Engelmann & Vasishth, 2009; Vasishth et al., 2010). It was suggested that German speakers could have counted on the number of commas in 2-CE-RCs and thereby, detected the missing VP2. Turkish does not require use of commas in RCs. In that regard it is similar to Dutch (Frank & Ernst, 2018; Frank et al., 2016). Thus, examining missing VP2 illusion in Turkish would inform on whether or not the illusion can be attributed to head-final properties of languages independent of punctuation requirements.

2.4 Interference-based account

The role of (working) memory has long been part of sentence processing models with respect to the limitations it places on the computational capacity of the parser

(e.g., Frazier & Fodor, 1978; Gibson, 1998; 2000; Kimball, 1973; Miller & Chomsky, 1963; Yngve, 1960). More recent models on memory and sentence processing focus on the idea that sentence processing is subject to general working memory processing principles and constraints that govern other cognitive domains, with no role for linguistically-specialized memory mechanisms (Lewis & Vasishth 2005; Lewis et al., 2006; among others).

A recent influential parsing model that has memory retrievals in its essence is the *cue-based parsing model* by Lewis and colleagues (Lewis & Vasishth, 2005; Lewis et al., 2006). The cue-based parsing model is built on the application of cognitive principles as specified in the broader cognitive model of Adaptive Control of Thought-Rationale (ACT-R) (Anderson & Lebiere, 1998) and defines sentence processing as "a series of skilled associative memory retrievals, modulated by similarity-based interference and the fluctuation of memory trace activation" (Lewis & Vasishth, 2005, p. 376).

In the cue-based parsing model, working memory processes in sentence processing are realized in three stages: encoding, storage and retrieval. Figure 2 below illustrates how a relationship between a probe, i.e., the verb *arrived,* and its target, i.e., the head of its subject *the toy,* is formed according to these three stages. In the first stage, when the noun *the toy* is processed, both a representation of the noun phrase (NP6 in Figure 2) and a representation of the expectation of its verb (S7 in Figure 2) are encoded in working memory. These representations are stored based on their content as feature bundles (e.g., word category, argument structure, case, number). In the second stage, other linguistic items, i.e., *from her uncle in Bogotá,* are encoded while the representations of *the toy* remain in working memory, outside the focus of attention, until its retrieval. In the third stage, upon processing the probe,

i.e., the verb *arrived,* the retrieval cues that are derived from the probe are generated as the features of the target to be retrieved. Then, the target item, the *toy,* is accessed by an associative, *content-addressable* retrieval process. In this process the retrieval cues of the probe are checked against all working memory representations, and the (target) item with features that match with the retrieval cues is accessed.

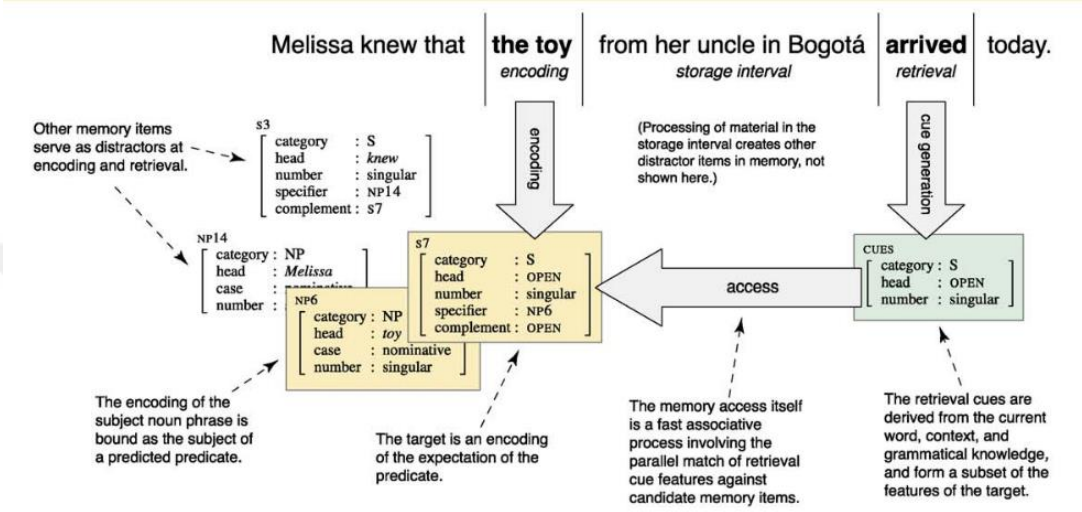


Figure 2. Working memory retrieval in cue-based parsing model (Taken from Lewis et al. (2006, p. 448))

Three cognitive principles of working memory processes inform the nature of retrieval in cue-based parsing. The first principle is *limited focus of attention* (McElree, 2000; 2006; McElree, Foraker, & Dyer, 2003). The principle of limited focus of attention claims that the amount of information that can be maintained in an active state in working memory is one to three items, and the information that is to be retrieved has to be brought into focus, i.e., be activated, to participate in processing. The second principle is *fast, parallel associative retrieval*, which maintains that multiple items whose features will be checked against the probe's retrieval cues are accessed in a fast, parallel manner (McElree & Dosher, 1989, 1993). The third principle is *slow, serial access to serial order* (Lewis, 2000; McElree, 2006). This principle claims that retrievals that require serial order information are too slow to support sentence comprehension. Thus, it is suggested

that there is no serial order representation in the human parser; instead, parsing is claimed to be based on cue-based associative retrievals (Lewis & Vasishth, 2005).

The three stages of encoding, storage and retrieval in the cue-based parsing model are constrained by two factors: (i) activation-based decay and (ii) similarity-based interference. Activation-based decay assumes that the activation of an item in working memory fluctuates based on time-based decay and usage history. That is, an item's activation level decays after it is first encountered and as other items are encountered. Although the activation level of a target item reduces as a function of the linear distance between the target item and its probe (e.g., Gibson, 1998; Van Dyke & Lewis, 2003; but cf. Konieczny, 2000 for German; Vasishth, 2003 for Hindi), what indicates the activation level of an item is the history of its retrievals rather than its distance to the probe. The fluctuations in the activation level of an item affect the retrieval latency and retrieval probability of that item.

Similarity-based interference claims that the strength of association between the cues of a probe and a target decreases as a function of the number of other items, i.e., distractors, with similar features. That is, similarity-based interference effects occur due to cue overlap between the target item and the distractor item(s). Similarity-based interference arises at both encoding and retrieval. *Encoding interference* is observed when encoding an item becomes more difficult as the number of preceding items that have similar features to that item increases. *Retrieval interference* is observed as an increased difficulty of retrieving a target item due to the increased number of distractors that have similar features to the retrieval cues of the probe. Lewis (1998) proposed a metric that illustrates retrieval interference effects, as illustrated in (33).

(33) $\varphi_1\ \varphi_2 \ldots \varphi_n\ X\ \rho_1\ \rho_2 \ldots \rho_m\ Y$

(Lewis & Nakayama, 2002, p. 88)

In the metric in (33), suppose that a syntactic relationship must be established between X and Y, and Y is the probe and X is the target in this relationship. The establishment of a relationship between X and Y may suffer from interference due to distractors, i.e., the items prior to X, i.e., $\varphi_1\ \varphi_2 \ldots \varphi_n$, and the intervening items between X and Y, i.e., $\rho_1\ \rho_2 \ldots \rho_m$. The critical assumption of similarity-based retrieval interference is that the amount of interference in retrieving the target item X for the probe Y is contingent upon the similarity between these distractors and the target item X. That is, whereas the probability of retrieving the target item X increases with a stronger match between X and the cues of its probe Y, it decreases with stronger matches between the distractors and the cues of Y. As the formula in (33) shows, retrieval interference may occur due to distractors that either precede or follow the target item. While *retroactive* retrieval interference is caused by the distractors that follow the target item, i.e., $\rho_1\ \rho_2 \ldots \rho_m$, *proactive* retrieval interference occurs due to the distractors that precede the target item, i.e., $\varphi_1\ \varphi_2 \ldots \varphi_n$.

In the case of center-embeddings the cue-based parsing model maintains that the difficulty in processing center-embedded structures is due to the similarity between the items and the lack of access to serial order information. As mentioned above, in the cue-based parsing model sentence processing relies on the distinction between the past (the items outside the focus attention) and the present (the items in the focus of attention) and the distinguishing cues for the retrieval of the correct target item. Lewis and colleagues argue that although these two principles of the cue-based parsing model mostly work well for general sentence comprehension, they fail

in doubly center-embedded structures (2-CE-RCs) as in (34), because in center-embedded constructions the target items, i.e., the subjects, are similar in such a way that they can only be discriminated based on their serial order information.

(34) [The reporter [who everyone [that I met] trusts] said the
NP1 NP2 NP3 VP3 VP2 VP1

president won't resign yet.]

(Häussler & Bader, 2015, p. 4)

In the sentence in (34), the three subject NPs, i.e., NP1, NP2 and NP3, are syntactically-similar, and they all match with the retrieval cues of the VPs, i.e., VP1, VP2 and VP3. The only way to distinguish these subject NPs is by their serial order information. But since the parser does not use serial order information in discriminating between the candidate items, the cue-based parsing model claims that the difficulties in processing 2-CE-RCs as in (34) occur mostly due to similarity-based interference effects that are observed at the retrieval of the subject NPs upon processing the VPs (Lewis & Vasishth, 2005; Lewis et al., 2006).

According to the cue-based parsing model, in the 2-CE-RC in (34) the point where the parser experiences the most difficulty is VP2, *trusts,* due to the retrieval interference effects that arise by the presence of two similar subject NPs that can be retrieved in parallel (Häussler & Bader, 2015). Specifically, upon processing VP3, *met,* three similar subject NPs, i.e., NP1, NP2 and NP3, can be retrieved. The subject NP3 can be correctly retrieved for VP3 with no retrieval interference effects because NP3 is the last item being encoded and is the most recent one to VP3 (e.g., Knoedler, Hellwig, & Neath, 1999). Upon processing VP2, *trusts*, however, there are two similar subject NPs that can be retrieved, i.e., NP1 and NP2, and its retrieval is subject to interference effects due to the presence of the similar subject NP1 that is also available for retrieval at that point. Moreover, NP1 is in the clause that is

encoded first and exploits the advantage or primacy; thus, the primacy advantage of NP1 may even contribute to its incorrect retrieval for VP2. The incorrect retrieval of NP1 for VP2 would result in further processing difficulties while processing VP1 as in that case there would be no subject NP available that can be retrieved for VP1. Lastly, upon processing VP1, *said*, the subject NP1 can be correctly retrieved thanks to the advantage of primacy. Therefore, the difficulty in processing 2-CE-RCs is mainly attributable to the retrieval interference effects due to the presence of two similar subject NPs at the point of VP2 and the possible incorrect retrieval of NP1 as the subject of VP2. Since the main reason for the processing difficulty in center-embedded structures is similarity-based retrieval interference effects, I will use the term (similarity-based) interference in this thesis when referring to the explanations of the cue-based parsing model for center-embedded structures.

Based on the role of similarity among the target subjects on center-embedding difficulty, similarity-based interference has been suggested as a factor that can modulate the processing difficulty of center-embedded structures (Lewis, 1996; 1998; 2000; Lewis & Vasishth, 2005; Lewis et al., 2006). Specifically, decreasing the similarity of the target subject (or object) NPs is argued to increase the processability of center-embedded structures because it eases the retrieval of the correct subject NPs by providing discriminating features that would better match with the retrieval cues generated by the verbs. The similarity of the subject NPs has been manipulated with respect to their syntactic (Lewis & Nakayama, 1999, 2002; Uehara, 2003; Uehara & Bradley, 1996), positional (Lewis & Nakayama, 2002; Vasishth, 2003), phonological (Nakayama et al., 2005; Uehara & Bradley, 1996; Vasishth, 2003) and/or semantic similarity (Nakayama et al., 2005). These studies are presented in more detail in Section 2.4.1.

Bader and Häussler (Bader, 2015; Häussler & Bader, 2015) extended the explanations of the similarity-based interference account to missing-VP2 illusion. Recall Frazier's (1985) observation that the omission of the second VP from 2-CE-RC structures as in (35) could go unnoticed, leading the ungrammatical sentence with a missing VP2, *admitted*, to be perceived as more (or no less) grammatical than its complete version with all three verbs present.

(35) [The patient [$_{RC1}$ who the nurse [$_{RC2}$ who the clinic] had hired]
NP1 NP2 NP3 VP3

admitted] met Jack.]
VP2 VP1

(Frazier, 1978, p. 178)

As discussed in the case of grammatical 2-CE-RCs above, when the parser processes VP3, its subject NP3, *the clinic,* is retrieved with no interference effects since it is the last item encoded, and hence the most available item for retrieval due to its recency. However, in a 2-CE-RC that lacks its VP2, upon processing VP1, *met,* there are two similar subject NPs that can be retrieved: NP1, *the patient,* and NP2, *the nurse.* The illusion is mainly related to the primacy of NP1. That is, due to the primacy advantage, NP1 can be correctly retrieved for VP1, and the lack of a VP for the subject NP2 may go unnoticed, leading to a grammaticality illusion. But note that the subject NP2 can also be incorrectly retrieved for VP1. In that case, the lack of a VP for the subject NP1 may be easily noticed thanks to the primacy advantage of the subject NP1 (see Bader, 2015; Häussler & Bader, 2015 in Section 2.4.2 for the testing of this prediction).

The predictions of the cue-based parsing model were tested in several experiments which examined the processing difficulty or missing-VP2 illusion in center-embeddings. The following two sections present those studies, respectively.

2.4.1 Interference-based account on center-embedding difficulty

As was discussed in the previous section, the cue-based parsing model maintains that the retrieval of a target item from memory is highly dependent on the similarity between the target item and the distractor item(s). That is, as the similarity between the target item and the distractor(s) increases, the probability of retrieving the target item also decreases due to interference effects by the similar distractor(s) (Lewis & Vasishth, 2005; Lewis et al., 2006). In the case of center-embedded structures, it is argued that the less similar the subject NPs, the easier the structure would be because with non-similar subjects, the target subjects would have distinguishing features and those features would more easily match with the retrieval cues of their verbs (Lewis, 1996). This section reviews the studies that investigated the role of similarity-based retrieval interference in processing center-embedded structures. Note that some of those studies were conducted before the proposal of the most recent version of the cue-based parsing model, but they all explain center-embedding difficulty with reference to similarity-based interference, which is considered to be the main cause of difficulty in center-embedded structures in the cue-based memory retrieval model.

In the studies investigating the role of similarity-based interference on center-embedding difficulty, syntactic, positional, phonological and semantic similarities were investigated. Syntactic similarity is manipulated with the number of NPs that are marked with the same case markings indicating their syntactic positions, e.g., NPs marked by the nominative case marker indicating their subject positions in the sentence. Positional similarity is manipulated with the adjacency of syntactically similar NPs. Phonological similarity is manipulated with the similarity of the NPs that are marked with phonologically identical case markers. Semantic similarity is manipulated with the similarity of the NPs in terms of their animacy. The main

prediction of the similarity-based interference account is that an increase in the number of arguments that are similar in their syntactic, positional, phonological and/or semantic features would lead to enhanced difficulty in processing center-embedded structures; the less similar the arguments are in these features, the easier the processing of the structure would be.

The studies that are presented in this section and in the following section (Section 2.4.2) investigated the role of similarity-based interference in languages with verb-final structures such as Japanese (Lewis & Nakayama, 1999; 2002; Nakayama et al., 2005; Uehara, 2003; Uehara & Bradley, 1996), Korean (Nakayama et al., 2005; Uehara & Bradley, 1996), Hindi (Vasishth, 2003), German (Bader et al., 2003; Häussler & Bader, 2015), Mandarin (Huang & Philips, 2020) and Turkish (Dokudan et al., 2017). Unlike the studies on verb-initial languages such as English (Frank & Ernst, 2018; Gibson & Thomas, 1999; Christiansen & MacDonald, 2009; Huang & Philips, 2020; Vasishth et al., 2010) and French (Gimenes et al., 2009) which employed center-embedded structures with relative clauses (CE-RCs) as their experimental stimuli, most of these studies on verb-final languages, excluding that on Mandarin by Huang and Philips (2020), employed center-embedded structures with sentential complements (CE-SCs). Although there are some structural differences between CE-SCs and CE-RCs (see Section 3.1 in Chapter 3 for a detailed discussion on these differences), both structures are employed to investigate the predictions of similarity-based interference account on center-embedded structures. In what follows, I report on the studies that investigated the predictions of the similarity-based interference account for center-embedding difficulty.

Uehara and Bradley (Uehara, 2003; Uehara & Bradley, 1996) conducted three experiments to investigate the role of syntactic and phonological similarity in

processing Japanese and Korean center-embeddings. In their Experiments 1 and 2, which were off-line processability judgment experiments, they examined whether or not increasing syntactic similarity, i.e., increasing the number of subject NPs marked by the same case marker, would enhance the difficulty of Japanese center-embeddings. In Experiment 1 there were ten conditions which were created in five pairs, manipulating the number of consecutive NPs marked with the same case marker *-ga* (three NPs marked with *-ga* as in (36a-40a) vs. two NPs marked with *-ga* as in (36b-40b)). The NP-*ga* sequence was decreased with *-ga/-no* conversion on the third NP in (36), *-ga/-wa* conversion on the first NP in (37-39), and with an adverb insertion in (40). The *-ga/-wa* conversion in (37-39) were tested in three different structures due to the constraints on the topicalization marker *-wa*. The structure was singly-embedded with an additional NP marked with the accusative marker *-o* in (37), doubly center-embedded in (38), and singly center-embedded with an additional NP marked with *-ga* in (39). In Experiment 2, in addition to the five pairs of Experiment 1, there was a sixth pair structurally similar to (36), in which the third NP was marked with the accusative case marker *-o* instead of the genitive case marking *-no* in (45b). In the sixth pair stative predicates, which allowed their object to be marked with either *-ga* or *-o*, were used.

(36) a. [-ga [$_{NP}$ [$_{IP}$ -ga [$_{NP}$ [$_{IP}$ **-ga** V]] V]] V]

b. [-ga [$_{NP}$ [$_{IP}$ -ga [$_{NP}$ [$_{IP}$ **-no** V]] V]] V]

(37) a. [**-ga** [$_{IP}$ -ga [$_{IP}$ -ga -o V] V] V]

b. [**-wa** [$_{IP}$ -ga [$_{IP}$ -ga -o V] V] V]

(38) a. [**-ga** [$_{NP}$ [$_{IP}$ -ga [$_{NP}$ [$_{IP}$ -ga V]] V]] V]

b. [**-wa** [$_{NP}$ [$_{IP}$ -ga [$_{NP}$ [$_{IP}$ -ga V]] V]] V]

(39) a. [**-ga** [IP -ga -ga [IP -ga V] V] V]

b. [**-wa** [IP -ga -ga [IP -ga V] V] V]

(40) a. [**-ga** [IP -ga [IP -ga -o V] **Adv** V] V]

b. [**-ga** [IP -ga **Adv** [IP -ga -o V] V] V]

(Uehara & Bradley, 1996, p. 190)

In Experiment 1 the participants' task was to rate how processable the sentences were, and in Experiment 2 the participants were asked to compare the processability of sentences which were presented in pairs, and judge whether one of them was more processable than the other. Uehara and Bradley predicted that if syntactic similarity increased the difficulty of Japanese center-embeddings, the sentences with more *ga*-marked NPs as in (36a-40a) would receive lower ratings than those with less *ga*-marked NPs as in (36b-40b).

The results of Experiments 1 and 2 showed that sentences with an increased number of NPs marked with *-ga* as in (36a-40a) were judged to be less processable than their counterparts with fewer NPs marked with *-ga* as in (36b-40b). Hence, Uehara and Bradley concluded that three-*ga* repetitions impaired the discriminability of the subject NPs, resulting in higher interference and lower processability. This was the case in both singly center-embeddings as in (37, 39, 40) and doubly center-embeddings as in (36, 38).

Uehara and Bradley argued that the increased processing difficulty with three-*ga* repetitions could also be attributed to their phonological similarity because the case marker that was manipulated for its repetition in Experiments 1 and 2 was not only syntactically but also phonologically the same. To test this prediction, they conducted Experiment 3, another off-line processability judgment experiment, but employing Korean center-embeddings. Unlike Japanese, in Korean there are two

forms of the nominative case marking, *-i* and *-ka*. *-i* is inflected to words ending in a consonant, and *-ka* is inflected to words ending in a vowel. The occurrence of two forms of nominative case marking in Korean allowed to find out whether increasing phonological similarity among the NPs would increase the difficulty of center-embedded structures. The results of Experiment 3 on Korean would also inform on whether the increased difficulty in the case of three-*ga* repetitions in Experiments 1 and 2 was due to only syntactic similarity or to also the identical phonological form of the case marking. There were four conditions in Experiment 3, manipulating the number of embeddings (doubly center-embeddings as in (41a-b) vs. singly center-embeddings as in (41c-d)) and the number of NPs marked with the same phonological form of the nominative case (three and two in (41a, c), respectively, vs. two and one in (41b, d), respectively).

(41) a. [Sachon-**i** [Kyengchal-**i** [Kiyeong-**i** wuncensa-lul
Sachon-NOM cousin-NOM police-NOM driver-ACC
ttayliessta] ko cwucanghanta] ko cenhay cwuessta]
hit that insisted that report gave
'My cousin told (me) that the police insisted that Kiyeong hit the driver.'

b. [Sachon-**i** [Kyengchal-**i** [Yengswu-**ka** wuncensa-lul
cousin-NOM police-NOM Yengswu-NOM driver-ACC
ttayliessta] ko cwucanghanta] ko cenhay cwuessta]
hit that insisted that report gave
'My cousin told (me) that the police insisted that Yengswu hit the driver.'

c. [Sachon-**i** [Kiyeong-**i** wuncensa-lul ttayliessta] ko
cousin-NOM Kiyeong -NOM driver-ACC hit that
cenhay cwuessta]
report gave
'My cousin told (me) that Kiyeong hit the driver.'

d. [Sachon-**i** [Yengswu-**ka** wuncensa-lul ttayliessta] ko
cousin-NOM Yengswu-NOM driver-ACC hit that
cenhay cwuessta]
report gave
'My cousin told (me) that Yengswu hit the driver.'

(Uehara & Bradley, 1996, p. 193)

Uehara and Bradley predicted that if phonological similarity increased the processing difficulty of Korean center-embeddings, the sentences with a higher phonological similarity among the NPs as in (41a, c) would receive lower ratings than those with less phonological similarity as in (41b, d). But if there were no phonological similarity effects, and the observed differences in Experiments 1 and 2 were not attributable to phonological similarity, there would be no difference in the ratings for sentences with increased and decreased phonological similarity.

The results showed lower ratings for doubly center-embeddings as in (41a-b) than singly center-embeddings as in (41c-d), confirming the increased difficulty in doubly center-embedded structures compared to singly center-embedded ones. For phonological similarity, there was no reliable difference between the sentences with higher phonological similarity as in (41a, c) and those with decreased phonological similarity as in (41b, d). There was no significant interaction between the number of embeddings and the number of NPs bearing the same phonological case marker,

either. Thus, Uehara and Bradley concluded that increasing phonological similarity did not lead to an enhanced processing difficulty in Korean center-embeddings, and the increased processing difficulty in Japanese center-embedding in Experiments 1 and 2 was not due to the repetition of the same phonological form, but due to the syntactic similarity of the subject NPs marked with the same case marker.

Uehara (2003) examined the effects of syntactic similarity, i.e., the number of NPs that were marked with the same case markings that indicate their syntactic positions, and positional similarity, i.e., the adjacency of syntactically similar NPs, on Japanese center-embeddings in a self-paced reading experiment. Uehara investigated whether or not the increased processing difficulty that resulted from the increased syntactic similarity in the case of 3-*ga* repetition in off-line measures in Uehara and Bradley's (1996) study would also emerge in on-line measures. There were eight conditions in the experiment; the sentences in (42) were doubly center-embeddings while those in (43) were singly center-embeddings. In doubly center-embeddings four conditions manipulated the place of the adverb for positional similarity (after the second subject NP as in (43a), resulting in two consecutive subject NPs, or the third NP as in (42b), resulting in three consecutive subject NPs), and the case marker on the first NP for syntactic similarity (resulting in two vs. three NPs with the nominative case marker -*ga* as in (42a-b)). In doubly center-embeddings, all three NPs that created the case manipulation were in the subject position. In singly center-embeddings, four conditions manipulated the case marking on the first NP as in doubly center-embeddings and the case marker on the third NP (marked with the nominative case marker -*ga* as in (43a) vs. the accusative case marker -*o* as in (43b)). The sentence with the first and third NPs marked with -*ga* as in (43a) resulted in the highest syntactic similarity with three *ga*-marked NPs. In

singly center-embeddings, whereas the first two NPs were in the subject position, the third NP was in the object position. In (42-43) case marking is in bold, and adverbs are in italic.

(42) a. [kakarichoo-**ga/-wa** [shokuin-**ga**
section chief-NOM/TOP employees-NOM
[Nakamura-san-**ga** *mezurasiku* jimushori-o
Nakamura-Mr./Ms.-NOM unusually accounting-ACC
matigaeta]-koto-o hinansite-iru]-no-o tasinameta.]
made error-fact-ACC criticizing-is-fact-ACC reprimanded
'The section chief reprimanded the workers for being critical of the fact that Mr./Ms. Nakamura uncharacteristically made an accounting error.'

b. [kakarichoo-**ga/-wa** [shokuin-**ga** *itumademo*
section chief-NOM/TOP employees-NOM endlessly
[Nakamura-san-**ga** jimushori-o
Nakamura-Mr./Ms.-NOM accounting-ACC
matigaeta]-koto-o hinansite-iru]-no-o tasinameta.]
made error-fact-ACC criticizing-is-fact-ACC reprimanded
'The section chief reprimanded the workers for being endlessly critical of the fact that Mr./Ms. Nakamura made an accounting error.'

(43) a. [hisho-**ga/-wa** [Morisita Shachoo-**ga** takusii-**ga**
secretary-NOM/TOP Morisita President-NOM taxi-NOM
hituyoo-da]-to uketuke-made ii-ni-kita.]
necessary-is-that reception desk-to tell-to-came
'The secretary came to the reception desk to report that President Morishita needs a taxi.'

b. [hisho-**ga/-wa** [Morisita Shachoo-**ga** takusii-**o**
secretary-NOM/TOP Morisita President-NOM taxi-ACC
yonde-aru]-to uketuke-made ii-ni-kita.]
called-has-that reception desk-to tell-to-came
'The secretary came to the reception desk to report that President Morishita had called a taxi.'

(Uehara, 2003, pp. 178-179)

The analyses of mean whole-sentence reading times showed that overall doubly center-embeddings as in (42) took longer to read than singly center-embeddings as in (43). For doubly center-embeddings, there was a significant interaction between syntactic and positional similarity, with the highest processing difficulty in the sentences with three consecutive subject NPs with *-ga* as in (42a). This finding was similar to Uehara and Bradley's (1996) findings with off-line data. For singly center-embeddings, whereas the sentences in which the first NP was marked with *-ga* as in (43a-b) took longer time to read than those in which the first NP was marked with *-wa* as in (43a-b), the case marking on the third NP (*-ga* as in (43a) vs. *-o* as in (43b)) did not significantly affect the processing difficulty of the sentences. Thus, unlike in Uehera and Bradley's (1996) study, the occurrence of three consecutive NPs with *-ga* did not decrease the processability of singly center-embeddings. Note that all

three NPs marked with *-ga* were in the subject position in doubly center-embeddings while only two of the three NPs with *-ga* were in the subject position in singly center-embeddings. Hence, Uehara concluded that the source of increased processing difficulty in the case of three-*ga* repetitions was attributable to the structural similarity of the three NPs, i.e., they were all in the subject position, as well as their syntactic similarity, i.e., they were marked with the same case marker *-ga*.

Nakayama et al. (2005) conducted seven experiments to investigate the role of similarity-based interference in processing Japanese and Korean center-embeddings. They conducted six experiments in Japanese for the effects of syntactic, positional and semantic similarity and one experiment in Korean for the effects of phonological similarity. The first two experiments examined positional similarity, i.e., the adjacency of syntactically similar NPs, and semantic similarity, i.e., the similarity of NPs in terms of their animacy. Experiment 1 was an off-line rating task and Experiment 2 was an on-line non-cumulative rating task. The experiments employed six conditions in singly center-embeddings in Japanese, and manipulated the positional similarity changing the number of consecutive, syntactically similar NPs (one as in (44a-c) and two as in (44d-f)) and the semantic similarity of the NPs changing their animacy (the number of animate nouns is two in (44c, f), three in (44b, e) and four in (44a, d)). In (44) the abbreviations "Ani" and "Inani" stand for animate and inanimate, respectively.

(44) a. [Kyoju-ga shacho-ni [daihyo-ga kokosei-o shinsasuru-to]
NP(Ani) NP(Ani) NP(Ani) NP(Ani)
yakusokushita.]
'The professor promised the president that the representative would examine high school students.'

b. [Ani-ga sensei-ni [onna-no-ko-ga basu-o untensuru-to]
NP(Ani) NP(Ani) NP(Ani) NP(Inani)
renrakushita.]
'The elder brother informed the teacher that a girl is going to drive a bus.'

c. [Kacho-ga kaisha-ni [hitobito-ga hoteru-o yoyakushita-to]
NP(Ani) NP(Inani) NP(Ani) NP(Inani)
hokokushita.]
'The section chief reported to the company that people made their own reservations at the hotel.'

d. [Otoko-no-ko-ga [hahaoya-ga isha-ni akachan-o miseta-to]
NP(Ani) NP(Ani) NP(Ani) NP(Ani)
omoidashita.]
'The boy remembered that the mother showed a baby to the doctor.'

e. [Haisha-ga [tsuyaku-ga daitoryo-ni nihongo-o oshieru-to]
NP(Ani) NP(Ani) NP(Ani) NP(Inani)
oboeteita.]
'The dentist remembered that the interpreter would teach Japanese to President.'

f. [Bengoshi-ga [shain-ga apato-ni shinbun-o kubaru-to] kimeta.]
NP(Ani) NP(Inani) NP(Ani) NP(Inani)
'The lawyer decided that an employee would deliver the newspaper to the apartment.'

(Nakayama et al., 2005, pp. 99-100)

They predicted for positional similarity that the sentences including a higher number of adjacent, syntactically similar NPs as in (44d-f) would be more difficult to process than those with a fewer number of adjacent subject NPs as in (44a-c). For semantic similarity, they predicted that the sentences including the highest number of NPs that are similar in animacy as in (44a, d) would be the most difficult to process.

The results of Experiments 1 and 2 showed that increasing positional similarity led to lower ratings in sentences with two consecutive *ga*-marked subject NPs as in (44d-f) than those with one *ga*-marked subject NP as in (44a-c). But there was no difference in the ratings of the sentences that differed in terms of the number of NPs with semantic similarity. Thus, although these experiments provided support for positional similarity effects, they did not show any evidence for semantic similarity. Nakayama et al. argued that this could be because the animacy manipulation may have been masked by the dissimilarity of the NPs in terms of their syntactic positions. That is, the NPs that were manipulated for their animacy were already differentiated by their syntactic positions.

Nakayama et al. conducted four additional experiments, i.e., Experiments 3-6, to investigate semantic similarity, i.e., the similarity of NPs in terms of their animacy, and syntactic similarity, i.e., the number of NPs that were marked with the same case markings that indicate their syntactic positions. These experiments specifically examined whether or not making the two syntactically similar NPs (i.e., two subjects with the same case marking) semantically distinct (i.e., animate vs. inanimate) could ease processing center-embedded structures. For syntactic similarity, they investigated whether or not increasing structural case similarity among the subject NPs would increase the processing difficulty of Japanese singly center-embeddings. Experimental stimuli manipulated semantic similarity among the

subject NPs (the first NP was always animate, and the second subject NP was animate as in (45a-d) vs. inanimate as in (45a-d)), and the case marking on the first NP for syntactic similarity (the topicalization marker *-wa* as in (45a, c) vs. the nominative case marker *-ga* as in (45b, d)). Experiment 3 employed the four conditions given in (45a-b), which included active intransitive embedded verbs. Experiment 4 utilized the four conditions in (45c-d), which had passive transitive embedded verbs. Experiment 5 included the four conditions in (45b, d), which had the same animacy manipulation as in Experiments 3 and 4. Also, Experiment 5 included a pair of sentences with intransitive and transitive embedded verbs as in (45b, d), respectively, in order to reveal if there was any difference between the two types of verbs. In (45) case marking is in bold.

(45) a. Yamaguchi-**wa** gakusei-**ga** / okane-**ga** nokotteiru-to yososhita.
NP(Ani)-TOP NP(Ani) / NP(Inani)-NOM
'Yamaguchi predicted students / money would remain.'

b. Yamaguchi-**ga** gakusei-**ga** / okane-**ga** nokotteiru-to yososhita.
NP(Ani)-NOM NP(Ani) / NP(Inani)-NOM
'Yamaguchi predicted students / money would remain.'

c. Yamaguchi-**wa** gakusei-**ga** / okane-**ga** nokosareteiru-to yososhita.
NP(Ani)-TOP NP(Ani) / NP(Inani)-NOM
'Yamaguchi predicted students / money would be left.'

d. Yamaguchi-**ga** gakusei-**ga** / okane-**ga** nokosareteiru-to yososhita.
NP(Ani)-NOM NP(Ani) / NP(Inani)-NOM
'Yamaguchi predicted students / money would be left.'

(Nakayama et al., 2005, p. 101)

Experiments 3-5 were difficulty rating tasks. The results showed that the sentences with increased syntactic similarity, i.e., those with two consecutive subject NPs with *-ga*, as in (45b, d) were perceived to be harder to process than those with one subject NP with *-ga* as in (45a, c), suggesting that increasing syntactic similarity decreased the processability of Japanese singly center-embeddings. Semantic similarity of the subject NPs did not affect the ratings in any of the experiments.

Experiment 6 was conducted to investigate the effects of syntactic and semantic similarity in on-line measures. This experiment employed a self-paced reading task, and reading times (RTs) were elicited for each word in the sentence. The experimental conditions were the same as in Experiment 3 (see (45a-b) above), but the experimental sentences in Experiment 6 were embedded in another clause to prevent any effects of sentence initial position in the RTs for the first NP and sentence final wrap-up effects in the RTs for the second VP. The RTs showed no significant difference at any word between the sentences with one animate noun as in (45a-b) and those with two animate nouns as in (45a-b). For syntactic similarity, the RTs at the second NP and the two VPs were longer in sentences with two subject NPs marked with *-ga* as in (45b) than in those with one subject NP marked with *-ga* as in (45a), but the difference did not reach statistical significance at any of these words. Thus, the RT data in Experiment 6 showed no significant effect of semantic or syntactic similarity. They attributed the lack of semantic similarity effects to the use of neutral verbs; that is, the verbs that they used did not have selectional restrictions in terms of animacy. They reported an additional questionnaire study which employed materials similar to those in Experiment 3 (see (45a-b) above), but with verbs which had selectional restrictions in terms of animacy. The results of this additional questionnaire showed that increasing semantic similarity between the NPs,

indeed, increased the difficulty of center-embedded structures when investigated with verbs with selectional restrictions.

As in Uehara and Bradley (1996), Nakayama et al. speculated that the increased difficulty in sentences with a higher number of syntactically similar NPs in Experiments 3-5 could also be attributed to phonological similarity, i.e., the similarity of the NPs that were marked with phonologically identical case markers. Recall from Uehara and Bradley's study that Korean has two forms of nominative case marking, *-i* for words ending in a consonant and *-ka* for words ending in a vowel, which makes it possible to differentiate syntactic similarity from phonological similarity. To test this prediction and syntactic similarity effects on Korean, Nakayama et al. carried out one final experiment, Experiment 7, which tested Korean singly center-embeddings through a difficulty rating task. The experiment had six conditions, manipulating the case marking on NP1 (marked with the topicalization marker *-num* as in (46a-b), the nominative marker *-ka* as in (46c-d), or the nominative marker *-i* in (46e-f)) and the phonological form of the nominative case marking on NP2 (*-ka* as in (46a, c, e) vs. *-i* as in (46b, d, f)).

(46) a. Euncwu-**nun** Yengay-**ka** kyoswu-lul chacawassta-ko kiekhayssta.
NP1 NP2

'Encwu remembered that Yengay had visited the professor.'

b. Euncwu-**nun** Hisen-**i** kyoswu-lul chacawassta-ko kiekhayssta.

'Encwu remembered that Hisen had visited the professor.'

c. Euncwu-**ka** Yengay-**ka** kyoswu-lul chacawassta-ko kiekhayssta.

'Encwu remembered that Yengay had visited the professor.'

d. Euncwu-**ka** Hisen-**i** kyoswu-lul chacawassta-ko kiekhayssta.

'Encwu remembered that Hisen had visited the professor.'

e. Hisen-**i** Euncwu-**ka** kyoswu-lul chacawassta-ko kiekhayssta.
'Hisen remembered that Encwu had visited the professor.'

f. Hisen-**i** Swuceng-**i** kyoswu-lul chacawassta-ko kiekhayssta.
'Hisen remembered that Swuceng had visited the professor.'

(Nakayama et al., 2005, p. 105)

For the topicalization marker, they estimated that the sentences with the topicalization marker *-nun* as in (46a-b) would receive higher ratings than the others because topicalized NPs are already established in the discourse, and hence, are easier to process. They also predicted that if phonological similarity increased the processing difficulty of Korean center-embeddings, the ratings would decrease for the sentences with two phonologically similar NPs as in (46c, f) compared to those with phonologically dissimilar NPs as in (46b, e).

The results showed higher ratings for the sentences with the topicalization marker on the first NP as in (46a-b) than for those with the nominative case marker as in (46c-f), confirming the predictions for an easier processing in sentences with topicalized NPs. For phonological similarity, contra the findings of Uehara and Bradley (1996), Nakayama et al. found that Korean singly center-embeddings with a higher phonological similarity as in (46c, f) were rated to be more difficult than those with less phonological similarity as in (46d, e), suggesting that phonologically similar NPs increased the difficulty of center-embedded structures. The difference regarding phonological similarity between Nakayama et al.'s and Uehara and Bradley's findings were attributed to their experimental stimuli. While there were only singly center-embeddings in Nakayama et al.'s study, there were doubly center-embeddings in addition to singly center-embeddings in Uehara and Bradley's study. Nakayama et al. argued that the inclusion of more complex sentences, i.e., doubly

center-embeddings, in Uehara and Bradley's study might have obscured the effects of phonological similarity. Overall, Nakayama et al. concluded that investigation of Japanese and Korean center-embedded structures provided evidence for similarity-based interference effects in that decreasing syntactic, phonological, semantic and positional similarity among the NPs makes their processing easier.

Lewis and Nakayama (1999, 2002) conducted five experiments to examine positional similarity effects, i.e., the adjacency of syntactically similar NPs, in Japanese singly center-embeddings. In Experiments 1-3 the experimental sentences examined the effects of positional similarity in four conditions, manipulating the number of stacked (subject or object) NPs (three as in (47a-b) vs. four as in (47c-d)) and the number of positionally similar NPs (positionally dissimilar NPs as in (47a, c) vs. two adjacent, syntactically similar NPs as in (47b, d)). In (47) case marking is in bold, and only the suffixes that mark case are indicated in the glosses.

(47) a. [Ani-**ga** sensei-**ni** [onna-no-ko-ga asondeiru-to]
elder brother-NOM teacher-DAT girl-NOM playing-that
renrakushita.]
notified
'My older brother notified the teacher that a girl was playing.'

b. [Haisha-**ga** [daitooryoo-**ga** tsuuyaku-o yonda-to]
dentist-NOM president-NOM interpreter-ACC called-that
oboeteita.]
remembered
'The dentist remembered that the President called the interpreter.'

c. [Kyooju-**ga** shachoo-**ni** [daihyoo-ga
professor-NOM president-DAT representative-NOM
kookoosei-o shinsasuru-to] yakusokushita.]
high school student-ACC examine-that promised
'The professor promised the company president that the representative would examine the high school student.'

d. [Seito-**ga** [kooshi-**ga** repootaa-ni sakka-o
student-NOM lecturer-NOM reporter-DAT author-ACC
shookaishita-to] kizuita.]
introduced-that noticed
'The student noticed that the lecturer introduced the author to the reporter.'

(Lewis & Nakayama, 2002, pp. 97-98)

In the experimental sentences, Experiments 1 and 2 employed common nouns and did not control for mora and letters while Experiment 3 utilized proper nouns instead of common nouns and controlled for mora. Experiment 1 was a pen-and-paper rating task, and Experiments 2 and 3 were on-line non-cumulative difficulty rating tasks. Whereas increasing positional similarity was expected to lead to higher processing difficulty, increasing the number of stacked NPs was not predicted to enhance the difficulty as it did not result in the consecutive occurrence of syntactically similar NPs, unlike in the case of increased positional similarity.

The results of all three experiments showed that the sentences with two syntactically similar subject NPs that are adjacent as in (47b, d) were perceived to be harder than those with one subject NP as in (47a, c), which provided support for the role of positional similarity in processing Japanese center-embedded sentences. Also,

it was revealed that the sentences with four-stacked NPs as in (47c-d) were rated to be more difficult than those with three-stacked NPs as in (47a-b), although the effect of the number of stacked-NPs was smaller than the effect of positional similarity. Lewis and Nakayama explained the small effect of the number of stacked NPs as a reduced interference effect among syntactically distinct NPs (see Eady & Fodor (1981) and Mazuka et al. (1989) in Section 2.1 for further explanations regarding stacked NPs).

Lewis and Nakayama conducted Experiments 4 and 5 to further examine the effects of positional similarity in Japanese center-embeddings. In these experiments, they scrambled the word order in experimental sentences predicting that it would reduce positional similarity and ease the processing of center-embedded structures. Experiment 4 was a pen-and-paper task, and Experiment 5 was an on-line rating task. These experiments had three conditions, manipulating the word order of the sentences (canonical word order as in (48a), complement clause moved to the beginning of the sentence as in (48b) or the embedded object moved to the front of the embedded subject as in (48c)). Due to scrambling, while the number of adjacent subject NPs were two in (48a), it was one in (48b-c). Thus, (48b-c) were predicted to be rated higher than (48a) due to lower positional similarity. They did not predict any reliable difference between (48b) and (48c).

(48) a. Keikan-ga ryooshin-ga kodomo-o sagasu-to
policeman-NOM parents-NOM child-ACC look for-that
kangaeta.
thought

b. Ryooshin-ga kodomo-o sagasu-to keikan-ga
parents-NOM child-ACC look for-that policeman-NOM
kangaeta.
thought

c. Keikan-ga kodomo-o ryooshin-ga sagasu-to
policeman-NOM child-ACC parents-NOM look for-that
kangaeta.
thought

'The policeman thought that the parents would look for their child.'

(Lewis & Nakayama, 2002, p. 102)

The ratings demonstrated that the sentences with higher positional similarity as in (48a) got lower ratings than those with lower positional similarity as in (48b), but not than those as in (48c). Lewis and Nakayama attributed the lack of a difference between the ratings for sentences as in (48a) and (48c) to two possibilities: (i) the unnaturalness of scrambling within the complement clauses when the matrix subject is overt and/or (ii) the garden-path effect resulting from an initial analysis of the matrix subject and embedded object being structured in the same clause. The lower ratings for the sentences in (48a) than those in (48b), on the other hand, provided further support for the increased difficulty in the case of increased positional similarity.

Vasishth (2003) investigated the role of similarity-based interference on the processing difficulty in Hindi center-embeddings in seven experiments. In Experiments 1 and 2 he tested the effects of phonological similarity. Experiment 1 employed an acceptability rating task, and Experiment 2 was a self-paced reading task. The Hindi case marker *-ko* has two different morphological functions: it marks

accusative case on direct objects or dative case on indirect objects. This allowed to examine phonological similarity effects in processing center-embedded sentences while controlling for syntactic similarity, unlike in the case of Japanese in which the phonological similarity could not be manipulated without also manipulating syntactic similarity (see Uehara; 2003; Uehara & Bradley, 1996 above). The experimental sentences in both Experiments 1 and 2 had four conditions manipulating the level of embeddings (one as in (49a, b) vs. two as in (49c, d)), and the number of objects case-marked by *-ko* (one as in (49a), two as in (49b, c) or three as in (49d)). Note that the morpho-syntactic function of *-ko* also differed in (49a-d). In (49a), the object was marked with dative case, in (49b) the first object was marked with dative case and the second object was marked with accusative case, in (49c) both objects were marked with dative case, and in (49d) the first two objects were marked with dative case and the third object was marked with accusative case.

(49) a. [Siitaa-ne Hari-**ko** [kitaab khariid-neko] kaha.]
Sita-ERG Hari-DAT book buy-INF told
'Sita told Hari to buy a book.'

b. [Siitaa-ne Hari-**ko** [kitaab-**ko** khariid-neko] kaha.]
Sita-ERG Hari-DAT book-ACC buy-INF told
'Sita told Hari to buy the book.'

c. [Siitaa-ne Hari-**ko** [Ravi-**ko** [kitaab khariid-neko]
Sita-ERG Hari-DAT Ravi-DAT book buy-INF
bol-neko] kahaa.]
tell-INF told
'Sita told Hari to tell Ravi to buy a book.'

d. [Siitaa-ne Hari-**ko** [Ravi-**ko** [kitaab-**ko** khariid-neko]
Sita-ERG Hari-DAT Ravi-DAT book-ACC buy-INF
bol-neko] kahaa.]
tell-INF told
'Sita told Hari to tell Ravi to buy the book.'

(Vasishth, 2003, p. 56-57)

The results of the rating task showed a main effect of number of embeddings, i.e., lower ratings for doubly center-embeddings as in (49c-d) than those for singly center-embedding as in (49a-b), and a main effect of case marking, i.e., lower ratings for the sentences with an increased number of *ko*-marked NPs as in (49b, d) than those with less *ko*-marked NPs as in (49a, c). Also, there was a significant interaction, showing the lowest ratings for the doubly center-embeddings which had three *ko*-marked-NPs as in (49d). The results of the self-paced reading task regarding phonological similarity were similar for both single-center-embeddings and double-center-embeddings. The RTs for the last NP, *kitaab(-ko)* (book-(ACC)), and the innermost verb, *khariid-neko* (buy-INF), were longer for the conditions with an increased number of *ko*-marked-objects in both singly center-embedded sentences as in (49b) and doubly center-embedded sentences as in (49d). Thus, the results provided evidence for an increased processing difficulty in sentences with a higher number of phonologically similar NPs.

Note that the manipulation of phonological similarity in Experiments 1 and 2, i.e., the increase in the number of *ko*-case-marked objects, was possible thanks to the accusative case marking on the final object, *kitaab-ko* (book) in (49), but the accusatively-case marked NP is also definite. Given that indefiniteness is the default for direct objects in Hindi, Vasishth argued that the increased difficulty in sentences

with the definite object NPs in (49b, d) compared to those with the indefinite object NPs as in (49a, c) may be attributable to the definiteness of the object NP as well as to increased phonological similarity. Experiment 3 was conducted to tease apart these two possibilities and also to investigate syntactic and positional similarity effects in Hindi center-embeddings. Hindi makes it possible to test the predictions for positional similarity because as in Japanese, it has a flexible word order. Experiment 3 was a self-paced reading experiment, which included six conditions. The conditions were compared in pairs to investigate the effect of definiteness, phonological similarity and positional similarity. The sentences in (50a-b) differed in terms of phonological similarity, i.e., the number of *ko*-marked NPs was two in (50a) while it was one in (50b). If there were phonological similarity effects, the innermost VP in the sentence in (50a) would have longer RTs than that in (50b). The sentences in (50b-c) also differed in terms of phonological similarity, i.e., the number of ablative-cased *se*-marked NPs was one in (50b) whereas it was two in (50c). This comparison was added to investigate whether increased processing difficulty would be observed when phonological similarity was increased with the ablative case marker -*se*. If -*se* caused phonological similarity effects as in the case of -*ko,* the innermost VP in the sentence in (50c) would have longer RTs than that in (50b). The sentences in (50d, f) differed in terms of the case marker that increased phonological similarity, i.e., two *se*-marked NPs in (50d) vs. two *ko*-marked NPs in (50f), and positional similarity, i.e., two adjacent, *se*-marked NPs in (50d) vs. no adjacent similarly case-marked NPs as in (50f). If unlike the case marker -*ko,* the ablative case marking -*se* did not cause phonological similarity effects, the innermost VP in the sentence with two *ko*-marked NPs as in (50f) was predicted to have longer RTs than that in the sentence with two *se*-marked NPs as in (50d). If -*se,* rather than -*ko,*

caused phonological similarity effects and/or increasing positional similarity resulted in greater difficulty, the innermost VP in the sentence with two adjacent, *se*-marked NPs as in (50d) would have longer RTs. The sentences in (50c-d) differed in terms of the definiteness of the final NP (bare form and indefinite in (50c) vs. accusative-marked and definite in (50d)) while the number of phonological similar NPs was the same, i.e., two *se*-marked NPs. This comparison was added to disentangle the effects of definiteness and phonological similarity. If it was definiteness rather than phonological similarity that caused increased difficulty, the final NP and the innermost VP in the sentences with a definite final NP as in (50d) were predicted to take longer to read than those with an indefinite NP as in (50c). The sentences in (50b, f) differed in terms of the number of *ko*-marked NPs, i.e., one in (50b) vs. two in (50f), and the definiteness of the final NP, i.e., indefinite in (50b) vs. indefinite in (50f). If it was phonological similarity rather than definiteness that caused increased difficulty, there would be no difference at the final NP, and the innermost VP was predicted to have longer RTs in the sentence in (50f). The sentences in (62e-f) also differed in terms of positional similarity, i.e., the number of adjacent, *ko*-marked NPs was two in (50e) vs. one in (50f). If there were positional similarity effects, the innermost VP in the sentence in (50f) would take longer to read. In (50) case marking is in bold.

(50) a. Siitaa-**ne** Hari-**ko** Ravi-**ko** kitaab le-neko kahaa
Sita-ERG Hari-DAT Ravi-DAT book take- INF told
'Sita told Hari to take a book from Ravi.'

b. Siitaa-**ne** Hari-**ko** Ravi-**se** kitaab le-neko kahaa
Sita-ERG Hari-DAT Ravi-ABL book take-INF told
'Sita told Hari to take a book from Ravi.'

c. Siitaa-**ne** Hari-**se** Ravi-**se** kitaab le-neko kahaa
Sita-ERG Hari-ABL Ravi-ABL book take-INF told
'Sita told Hari to take a book from Ravi.'

d. Siitaa-**ne** Hari-**se** Ravi-**se** kitaab-**ko** le-neko kahaa
Sita-ERG Hari-ABL Ravi-ABL book-ACC take-INF told
'Sita told Hari to take the book from Ravi.'

e. Siitaa-**ne** Hari-**se** Ravi-**ko** kitaab-**ko** de-neko kahaa
Sita-ERG Hari-ABL Ravi-DAT book-ACC give- INF told
'Sita told Hari to give the book to Ravi.'

f. Siitaa-**ne** Hari-**ko** Ravi-**se** kitaab-**ko** le-neko kahaa
Sita-ERG Hari-DAT Ravi-ABL book-ACC take-INF told
'Sita told Hari to take a book from Ravi.'

(Vasishth, 2003, pp. 79-80)

The results showed that the innermost VP in the sentence with two *ko*-marked-NPs as in (50a) took longer time to read than that in the sentence with one *ko*-marked-NP as in (50b). But no reading time difference was found at the innermost VP between the sentences with two *se*-marked-NPs as in (50c) and those with one *se*-marked-NP as in (50b). Thus, these findings provided evidence for an increased difficulty in the case of increased phonological similarity with *-ko* but not with *-se.* Also, since the case marker *-ko* that differed in its syntactic functions caused similarity-based interference, Vasishth concluded that the effects were due to phonological similarity rather than syntactic similarity. The RTs at the innermost VP was longer in the sentence with two *ko*-marked NPs as in (50f) than that in the sentence with two *se*-marked NPs as in (50d), which provided further evidence that whereas *-ko* caused phonological similarity effects, *-se* did not. The results showed that the definite, *ko*-

marked last NP in (50d) and (50f) took longer time to read than the indefinite, bare last NP in (50c) and (50b), respectively. These results showed that in Hindi it was more difficult to process definite direct objects than indefinite objects. Also, the innermost VP in the sentence with two *ko*-marked NPs as in (50f) took longer time to read than that in the sentence with one *ko*-marked NP as in (50b), showing further evidence for greater difficulty with increased phonological similarity with *-ko.* There was no reliable difference between the RTs at the innermost VP in the sentence with two adjacent, *ko*-marked NPs in (50e) and that in the sentence with one *ko*-marked NP as in (50f), which failed to confirm the predictions of positional similarity. Overall, Vasishth concluded that Experiment 3 provided evidence for an increased difficulty with definite objects and phonological similarity effects with *-ko,* but no evidence for phonological similarity with *-se* or positional similarity. Vasishth concluded that the null results regarding phonological similarity with *-se* and positional similarity was inconclusive, and further studies were needed.

Due to the null results for positional similarity in Experiment 3, Vasishth conducted Experiments 4-7 to further investigate the predictions for positional similarity. The word order of the constituents was manipulated in these experiments such that the number of syntactically similar, adjacent NPs was different. Experiment 4 was an acceptability rating task, and Experiment 5 was a self-paced reading task. Both experiments employed four conditions, manipulating the position of the indirect object of the matrix clause (the indirect object was in its canonical position, i.e., before the direct object, as in (51a-b) vs. it was fronted to the sentence-initial position as in (51c-d), resulting in decreased positional similarity) and the presence of the case marking on the direct object NP, *kitaab* (book) (in bare form as in (51a, c)

vs. marked with the accusative case *-ko* as in (51b, d)). In (51) case marking is in bold.

(51) a. Siitaa-ne Hari-**ko** kitaab khariid-neko kahaa
Sita-ERG Hari-DAT book buy- INF told
'Sita told Hari to buy a book.'

b. Siitaa-ne Hari-**ko** kitaab-**ko** khariid-neko kahaa
Sita-ERG Hari-DAT book-ACC buy- INF told
'Sita told Hari to buy the book.'

c. Hari-**ko** Sita-ne kitaab khariid-neko kahaa
Hari-DAT Sita-ERG book buy- INF told
'It was Hari who Sita told to buy a book.'

d. Hari-**ko** Sita-ne kitaab-**ko** khariid-neko kahaa
Hari-DAT Sita-ERG book-ACC buy- INF told
'It was Hari who Sita told to buy the book.'

(Vasishth, 2003, p. 106)

Vasishth predicted that if increased positional similarity led to greater processing difficulty, the sentences with higher positional similarity as in (51a-b) would be more difficult to process than those with less positional similarity as in (51c-d), and if the definiteness effect would be observed again, the sentences with a case-marked, definite final NP as in (51b, d) would be more difficult than those with a bare, indefinite final NP as in (51a, c).

The results of the rating task from Experiment 4 showed no main effect of word order, but a main effect of definiteness, i.e., the sentences with a case-marked final NP as in (51b, d) received lower ratings than those with a bare final NP as in (51a, c). Furthermore, there was a significant interaction between word order and

definiteness such that the definiteness of the final NP led to the greatest processing difficulty in the sentences with canonical word order, i.e., those with two adjacent, *ko*-marked NPs, as in (51b). Overall, the results of Experiment 4 provided further support for the definiteness effect and partial evidence for positional similarity.

The data from the self-paced reading task, Experiment 5, were analyzed for the second and third NPs, and the innermost and final VPs. For case marking, the RTs at the innermost VP in the canonically-ordered sentences with a *ko*-marked final NP as in (51b) were longer than that in the canonically-ordered sentences with a bare final NP as in (51a). But in the sentences with a fronted indirect-object there was no reliable difference between the RTs at the innermost VP in sentences with a *ko*-marked direct object NP as in (51d) and that in sentences with a bare NP as in (51c). For word order, the innermost VP in the indirect-object fronted sentences with a bare final NP as in (51c) and the second NP in those with a case-marked NP as in (51d) took longer time to read than those in the sentences with canonical word order as in (51a) and (51b), respectively. These results provided evidence for positional similarity effects in that having a *ko*-marked final NP resulted in enhanced processing difficulty when there was an adjacent *ko*-marked NP as in (51b) compared when there was no adjacent *ko*-marked NP as in (51d).

Experiment 6 was another self-paced reading task, investigating the effects of definiteness and positional similarity. Unlike Experiments 4 and 5 which manipulated the position of indirect objects for positional similarity, Experiment 6 manipulated the position of direct objects. Experiment 6 employed four conditions, manipulating the position of the direct object, *kitaab* (book) (in its canonical position as in (52a, c) vs. fronted to the sentence-initial position as in (52b, d), decreasing positional similarity) and the case marking on the direct object NP, *kitaab* (book), as

in previous experiments (in bare form as in (52a-b) vs. marked with the accusative marker -*ko* as in (52c-d)).

(52) a. riinaa-**ne** siitaa-**ko** kitaab khariid-neko kahaa.
Rina-ERG Sita-DAT book buy-INF told
'Rina told Sita to buy a book.'

b. kitaab riinaa-**ne** siitaa-**ko** khariid-neko kahii.
book Rina-ERG Sita-DAT buy- INF told
'It was the book that Rina told Sita to buy.'

c. riinaa-**ne** siitaa-**ko** kitaab-**ko** khariid-neko kahaa.
Rina-ERG Sita-DAT book-ACC buy- INF told
'Rina told Sita to buy the book.'

d. kitaab-**ko** riinaa-**ne** siitaa-**ko** khariid-neko kahaa.
book-ACC Rina-ERG Sita-DAT buy- INF told
'It was the book that Rina told Sita to buy.'

(Vasishth, 2003, pp. 129-130)

Vasishth estimated that if positional similarity effects resulted in increased difficulty in direct-fronted sentences as well, the sentences with higher positional similarity as in (52c-d) would be more difficult to process than those with less positional similarity as in (52a-b), and if definiteness effect would be observed again, the sentences in which the direct object NP, *kitaab* (book), was case-marked and definite as in (52b, d) would be more difficult than those with an indefinite final NP as in (52a, c).

For case marking the results of the RT analyses revealed that in the sentences with the canonical word order both the direct object NP, *kitaab* (book), and the innermost VP took longer time to read when the final direct object NP was *ko*-

marked as in (52c) than when it was in bare form as in (52a); but in the direct-object-fronted sentences there was no reliable difference between the RTs of the sentences with *ko*-marked direct object NP as in (52d) or bare direct object NP as in (52b). These findings partially replicated the results of an increased processing difficulty due to a definite NP or increased phonological similarity in previous experiments. For the position of direct objects it was shown that the RTs at the innermost verb were longer in the direct-object fronted sentences than in the canonical sentences in both sentences with a *ko*-marked direct object NP as in (52d vs. 52c) and in the sentences with a bare direct object NP as in (52b vs. 52a). The findings for longer RTs in the sentences with one *ko*-marked NP as in (52d) than those with two *ko*-marked NPs as in (52c) provided counter evidence for positional similarity effects.

Experiments 4-6 provided partial evidence for phonological similarity in that having two *ko*-marked NPs resulted in higher processing difficulty than having one *ko*-marked NP. Furthermore, the results of Experiments 4-6 showed that having non-canonical sentences by fronting the indirect (Experiments 4-5) or direct objects (Experiments 6) led to longer RTs. Although this difference could be explained with positional similarity effects in some cases (see above for details), Vasishth noted that it may also be explained with Gibson's (2000) distance-based account in that increasing the distance between NPs and their verbs by changing the word order of the constituents led to an increased processing difficulty. To investigate whether these observed effects between the canonical and object-fronted sentences in Experiments 4-6 were due to positional similarity or increased distance, Vasishth conducted Experiment 7. Experiment 7 was a self-paced reading experiment which employed four conditions, manipulating the number of embeddings (one as in (53a-b) vs. two as in (53c-d)) and the presence of an adverb before the innermost verb,

i.e., the sentences in (53b, d) had an adverb before the innermost verb to increase the distance between NPs and their verbs whereas those in (53a, c) did not. In (53) the additional adverbs are in italic.

(53) a. Siitaa-ne Hari-ko [kitaab-ko khariid-neko] kahaa.
Sita-ERG Hari-DAT book-ACC buy-INF told
'Sita told Hari to buy the book.'

b. Siitaa-ne Hari-ko [kitaab-ko *jitne-jaldi-ho-sake*
Sita-ERG Hari-DAT book-ACC as-soon-as-possible
khariid-neko] kahaa
buy-INF told
'Sita told Hari to buy the book as soon as possible.'

c. Siitaa-ne Hari-ko Ravi-ko [kitaab-ko khariid-neko]
Sita-ERG Hari-DAT Ravi-DAT book-ACC buy-INF
bol-neko kahaa
tell-INF told
'Sita told Hari to tell Ravi to buy the book.'

d. Siitaa-ne Hari-ko Ravi-ko [kitaab-ko
Sita-ERG Hari-DAT Ravi-DAT book-ACC
jitne-jaldi-ho-sake khariid-neko] bol-neko kahaa
as-soon-as-possible buy-INF tell-INF told
'Sita told Hari to tell Ravi to buy the book as soon as possible.'

(Vasishth, 2003, pp. 148-149)

Vasishth predicted that if the observed differences for an increased difficulty in sentences with scrambled constituents were due to the increased distance as estimated by Gibson's (2000) account, the sentences in which the subject NP was

distant from its verb with the inclusion of an adverb as in (53b, d) would result in an increased processing difficulty compared to those without an adverb as in (53a, c).

The results showed that in singly center-embedded sentences there was no difference between the RTs of the innermost verb in sentences with an adverb as in (53b) and those without an adverb as in (53a). But in doubly center-embeddings the RTs at the innermost verb were shorter in sentences with an adverb as in (53d) than those without an adverb as in (53c), disconfirming the predictions of distance-based accounts by showing evidence for decreased processing difficulty with increased distance. Thus, Vasishth concluded that the findings of Experiment 7 confirmed that the increased difficulty in sentences with adjacent, syntactically similar NPs in non-canonical sentences in Experiments 4-6 was due to positional similarity rather than increased distance.

Overall, the seven experiments in Vasishth's study showed that the processing difficulty of Hindi center-embeddings was modulated by phonological and positional similarity of the (subject or object) NPs. Increasing both phonological and positional similarity of the NPs resulted in greater interference, which increased the difficulty of processing the construction.

The studies that have been reviewed in this section showed that decreasing the similarity of the subject or object NPs may ease the processing of center-embedded structures. A decrease in the number of NPs that are similar in terms of their syntactic, i.e, NPs marked with the same case markings that indicate their syntactic positions (Lewis & Nakayama, 1999; 2002; Uehara, 2003; Uehara & Bradley, 1996 for Japanese) and positional features, i.e., syntactically similar NPs that are adjacent to one another (Lewis & Nakayama, 1999; 2002 for Japanese; Vasishth, 2003 for Hindi) was shown to ease the processing of center-embedded

structures. But the studies investigating the effects of phonological, i.e., similarity of the NPs in terms of their phonological case marking, and semantic similarity, i.e., similarity of the NPs in terms of animacy, were inconclusive. For phonological similarity effects, whereas some studies showed evidence for an enhanced processing difficulty with an increased number of phonologically similar NPs (Nakayama et al., 2005 for Korean; Vasishth, 2003 for Hindi), others failed to support that (Uehara & Bradley, 1996 for Korean). For semantic similarity, while increased semantic similarity increased processing difficulty in sentences including verbs with selectional restrictions (Nakayama et al., 2005), no semantic similarity effects were found when the experimental stimuli had neutral verbs, i.e., verbs with no selectional restrictions (Lewis & Nakayama, 2002; Nakayama et al., 2005).

The next section reviews the studies examining the predictions of interference-based similarity on missing-VP (VP1 or VP2) illusion in center-embedded sentences.

2.4.2 Interference-based account on missing-VP2 illusion

The predictions of the interference-based account were also tested in relation to missing-VP (V2 or VP3) illusion in center-embedded sentences. Two studies on German center-embeddings (Bader, 2015; Häussler and Bader, 2015), one study on Turkish center-embeddings (Dokudan et al., 2017) and one study on Mandarin Chinese (Huag & Phillips, 2020) tested the predictions of the interference-based account for missing-VP illusion. They all provided evidence for the presence of missing-VP2 (or NP in the case of Mandarin) in these languages, and explained their findings with reference to the predictions of the interference-based account.

Recall from Section 2.4 that in processing doubly center-embeddings, the first subject, NP1, may have a primacy effect which has been claimed to contribute to the presence of a missing-VP2 illusion and to the absence of a missing-VP1 illusion (Bader, 2015; Häussler & Bader, 2015). That is, in doubly center-embeddings with a missing VP2, thanks to its primacy advantage, NP1 may be retrieved as the subject of VP1 and the lack of a VP for NP2 can go unnoticed, leading to a grammaticality illusion. In doubly center-embeddings with a missing VP1, on the other hand, the primacy advantage of NP1 increases the probability of noticing the lack of a verb for NP1, i.e., the lack of VP1, resulting in the absence of missing-VP1 illusion. Häussler and Bader (2015) tested these predictions in German center-embeddings. Their Experiment 1 was a binary grammaticality judgment task. This experiment employed six conditions manipulating the clause type of the subject NP1 (NP1 as the subject of an embedded clause as in (54a) vs. the subject of a matrix clause as in (54b)) and grammaticality (grammatical with all three VPs present, ungrammatical due to a missing VP2, *verursacht hat* (has caused) as in (54a-b), or ungrammatical due to a missing VP1, *verschwunden ist* (is disappeared) as in (54a-b)).

(54) a. Ich habe gehört dass seit heute Mittag die Praktikantin,
I have heard that since today noon the intern
NP1

die den Systemabsturz, der die Technikerin für etliche
who the system crash which the engineer for several
Stunden beschäftigt hatte, verursacht hat, verschwunden ist.
ours occupied had caused has disappeared is
VP3 VP2 VP1

'I have heard that the intern who caused the system crash which occupied the engineer for several hours disappeared since noon.'

b. Seit heute Mittag ist die Praktikantin, die den Systemabsturz,
since today noon is the intern who the system crash
NP1

der die Technikerin für etliche Stunden beschäftigt hatte,
who the engineer for several hours occupied had
VP3

verursacht hat, verschwunden.
caused has disappeared
VP2 VP1

'Since noon, the intern who caused the system crash which occupied the engineer for several hours is missing.'

(Häussler & Bader, 2015, p. 8)

It was predicted that if missing-VP2 illusion was available in German 2-CE-RCs, it would be observed irrespective of the clause type of the subject NP1, and the ratings for the ungrammatical conditions due to a missing VP2 would be higher than those in the grammatical conditions. But it was predicted that missing-VP1 illusion would be dependent on the primacy advantage of the subject NP1: there

would be no missing-VP1 illusion in sentences in which NP1 was the subject of a main clause as in (54b) due to the primacy advantage of NP1 while missing-VP1 illusion was expected in the sentences in which NP1 was the subject of an embedded clause as in (54a).

The results showed for clause type that the sentences in which NP1 was the subject of an embedded clause as in (54a) received higher acceptance rates than those in which NP1 was the subject of a main clause as in (54b) (52% vs. 41%). For grammaticality, it was revealed that grammatical sentences received higher acceptance rates than ungrammatical sentences with a missing-VP2 (81% vs. 37%), which, then, received higher acceptance rates than sentences with a missing VP1 (22%). The overall acceptance rate of the ungrammatical sentences with a missing VP1 or VP2 as grammatical was 29%. The overall acceptance rate of ungrammatical sentences was taken as evidence for a missing-VP illusion in German center-embeddings. Pairwise comparisons revealed that the ratings for missing-VP2 sentences did not change depending the clause type; but missing-VP1 sentences in which NP1 was the subject of an embedded clause as in (54a) were more often judged as grammatical than those in which NP1 was the subject of a matrix clause as in (54b). That is, although missing-VP2 illusion occurred in sentences with both clause types, missing-VP1 illusion was restricted to sentences in which NP1 was the subject of an embedded clause. Häussler and Bader concluded that these results confirmed the predictions of the primacy advantage in the interference-based account.

Häussler and Bader's second experiment was a word-by-word non-cumulative self-paced reading task. Experiment 2 examined (i) if the missing-VP illusion in German 2-CE-RCs that was revealed in the off-line measures would also

be observed in an on-line reading measure, and (ii) if number marking would modulate the processing difficulty of grammatical center-embeddings and missing-VP2 illusion. This experiment employed four conditions manipulating the grammaticality of the sentences (grammatical with all three VPs present vs. ungrammatical due to a missing VP2, *alarmiert hat* (has alarmed) as in (55a) and *alarmiert haben* (have alarmed) as in (55b)), and the number marking on NP2 and VP2 (singular (SG) as in (55a) vs. plural (PL) as in (55b)).

(55) a. Ich glaube dass man den Direktor, der den
NP2-SG

I think that one the principal-SG who-SG the

Schulrat der das Projekt absegnen soll,

schools inspector who-SG the project approve should

alarmiert hat belogen hat, um von dem eigentlichen
VP2-SG

alarmed has.SG lied to has for from the actual

Problem abzulenken

problem distract

'I think that the principal who alarmed the schools inspector who was supposed to approve the project was lied to in order to distract him from the actual problem.'

b. Ich glaube dass man die Direktoren, die den
NP2-PL

I think that one the principal-PL who-SG the

Schulrat der das Projekt absegnen soll,

schools inspector who-SG the project approve should

alarmiert haben belogen hat um von dem eigentlichen
VP2-PL

alarmed have.PL lied to has for from the actual

Problem abzulenken

problem distract

'I think that the principals who alarmed the schools inspector who was supposed to approve the project was lied to in order to distract him from the actual problem.'

(Häussler & Bader, 2015, p. 11)

It was predicted that if missing-VP2 illusion occurred during real-time processing of center-embedded structures, the RTs for VP1 would be shorter in the ungrammatical conditions than those in the grammatical conditions. The plural marking of the subject NP2 was predicted to lead to enhanced processing difficulties in both grammatical and ungrammatical sentences. This was because in the grammatical sentences, upon processing VP2 the attempt to retrieve singular NP1 for plural VP2 as in (67b) would result in an agreement violation. As a result, further processing difficulties were expected upon processing VP1 as there would be no available subject for retrieval. In ungrammatical sentences, upon processing VP1, which is always singular, the attempt to retrieve the plural subject NP2 would result in an agreement violation. Both of these agreement violations that were expected to occur

in the case of plural NP2 and VP2 were predicted to lead to greater processing difficulty, and thus, longer RTs.

The results showed that the RTs at VP1 were shorter in the ungrammatical sentences with a missing VP2 as in (55a-b) than those in their grammatical versions as in (55a-b), confirming the presence of missing-VP2 illusion in German 2-CE-RCs with on-line reading data. But there was no significant effect of number marking. Häussler and Bader argue that the lack of significant effects for the number manipulation could be due to the absence of any explicit judgments about the sentences. That is, the temporary agreement violations in conditions with a plural NP2 may have been internally repaired by the parser, leaving no observable effects for the RTs.

Bader (2015) conducted a speeded grammaticality judgment experiment and a corpus study to test (i) whether or not the processing difficulty of German 2-CE-RCs was different depending on the sentence position of center-embeddings, and (ii) whether or not this would affect the presence of missing-VP2 illusion in German center-embeddings. Recall that Vasishth et al. (2010) (Section 2.3) demonstrated that there was no missing-VP2 illusion in German center-embeddings, but Häussler and Bader (2015) (above) showed evidence for the presence of missing-VP1 and missing-VP2 illusions. Bader argued that the difference between those studies could be due to the difference in their experimental stimuli, i.e., the difference in the sentence position of the center-embedded structures. That is, whereas the center-embedded structures in Vasishth et al.'s study were all in the sentence-initial position, those in Häussler and Bader's included those in a sentence-medial position. Bader argued that the increased probability of detecting a missing VP2 in German center-embeddings in the sentence-initial position could be attributed to two reasons.

First, a missing VP may be more likely to be detected in center-embeddings in the sentence-initial position due to the lower storage cost in these sentences. Second, whereas the innermost VP, VP3, and the middle VP, VP2, are structurally similar, both are verb-final, in center-embeddings in the sentence-initial position, in center-embeddings in the sentence-medial position they are dissimilar: VP2 is inside a verb-final VP and VP1 is in a verb-second position. Thus, the structural difference between VP2 and VP1 in 2-CE-RCs in the sentence-initial position may help the parser distinguish between the two verb positions, which increases the likelihood of detecting a missing VP in 2-CE-RCs in the sentence-initial position.

To test this possibility, Bader conducted a grammaticality judgment experiment. The experiment had six conditions manipulating the sentence position of German center-embeddings (sentence-initial in a main clause as in (56a), sentence-medial in a main clause as in (56b), or sentence-medial in an embedded clause as in (56c)), and the grammaticality of the sentence (grammatical with all three VPs present as in (56a-c) vs. ungrammatical due to a missing VP2, *gefasst hat* (has caught) as in (56a-c)). Note that in both (56a) and (56b), the 2-CE-RC structure was the main clause, but in (56c), it was further embedded inside another matrix clause in (56c). Moreover, an adverb phrase was added at the beginning of the sentence in (56b) to have the center-embedded structure in a sentence-medial position of a main clause.

(56) a. Der Polizist, der den Verbrecher, der die Bank
the policeman who the criminal who the bank
überfallen hatte, gefasst hat, wird eine Auszeichnung erhalten.
VP2
robbed has caught has will a award get
'The policeman who caught the criminal who had robbed the bank will get an award.'

b. Vermutlich wird der Polizist, der den Verbrecher, der die
presumably will the policeman who the criminal who the
Bank überfallen hatte, gefasst hat, eine Auszeichnung erhalten.
bank robbed has caught has a award get
'Presumably, the policeman who caught the criminal who had robbed the bank will get an award.'

c. In der Zeitung stand, dass der Polizist, der den
in the newspaper stood that the policeman who the
Verbrecher der die Bank überfallen hatte, gefasst hat,
criminal who the bank robbed had caught has
eine Auszeichnung erhalten wird.
a award get will
'The newspaper reported that the policeman who caught the criminal who had robbed the bank will get an award.'

(Bader, 2015, p. 21)

The participants' task was to judge the sentences as grammatical or ungrammatical. Bader predicted that processing German center-embeddings and detecting the missing VP2 would be the easiest when the structure was in the sentence-initial

position as in (56a) due to a lower storage and the dissimilarity between VP2 and VP1 in these sentences.

The judgment data showed a higher acceptability percentage for the grammatical sentences (76%) than the ungrammatical sentences with a missing VP2 (41%), but sentence position did not overall affect the judgments. Pairwise comparisons indicated for grammatical sentences that the sentences in which the 2-CE-RC structure was in the sentence-initial position as in (56a) were more often judged as grammatical than those in which the structure was in the sentence-medial position in an embedded clause as in (56c), which were in turn more often judged as grammatical than those in which the structure was in the sentence-medial position in a main clause as in (56b). For the ungrammatical sentences, the percentage of grammatical judgments were lower in the sentences in which the structure was in the sentence-initial position as in (56a) than those in which the structure was in a sentence-medial position in an embedded clause as in (56c), but there was no significant difference between the two sentence-medial positions as in (56b-c). Hence, the results showed that when the 2-CE-RC structure was in the sentence-initial position, they were the easiest to process, and it was the easiest to detect the missing VP2 in these sentences.

Bader also examined a written German corpus (deWac corpus, Baroni, Bernardini, Ferraresi, & Zanchetta, 2009) to test if center-embedded structures with a missing-VP2 occurred in language production. The corpus data showed partially similar results to the experimental data: the proportion of missing-VP2 sentences to grammatical sentences was higher in sentences in which the 2-CE-RC structure was in the sentence-medial position (both in a main and an embedded clause) than those in the sentence-initial position. Therefore, Bader concluded that missing-VP2

illusion was present in German, both in language comprehension and language production, and it was dependent on the position of center-embeddings in the sentence.

Dokudan et al. (2017) conducted an experiment to investigate missing-VP2 illusion in Turkish center-embeddings. Their study extended the predictions of the interference-based accounts to theta-role assignment. They predicted that in ungrammatical sentences with a missing VP2, when the subject of the missing VP2 received a theta-role from another source such as an RC modifying it, ungrammatical sentences would be more likely to be judged as acceptable because the absence of theta roles may otherwise serve as a cue for the retrieval of constituents with unsatisfied dependencies. Their experiment had six conditions on Turkish doubly center-embeddings with sentential complements (2-CE-SCs) (see Chapter 3, Section 1 for the syntax of Turkish 2-CE-SCs). The conditions manipulated grammaticality (grammatical with all three VPs present as in (57a-c) vs. ungrammatical due to a missing VP2, *dinlemesini* (listen to), as in (57a-c)) and the presence of additional theta roles (subject NPs not modified as in (57a), modified by RCs and received additional theta roles in (57b) or modified by adjectives but did not receive theta roles as in (57c)).

(57) a. Ben biliyorum [haberci-nin [polis-in [öğretmen-in
I know journalist-GEN cop-GEN teacher-GEN
konuşmasını] dinlemesini] görüntülediğini.]
speak listen to VP2 film

'I know that the journalist filmed the cop listening to the teacher speak.'

b. Ben biliyorum [geçen gel-en haberci-nin [bugün
I know recently come-PART journalist-GEN today
öl-en polis-in [hastalan-an öğretmen-in konuşmasını]
die-PART cop-GEN get.ill-PART teacher-GEN speak
dinlemesini] görüntülediğini.]
listen.to film
'I know that the journalist who visited recently filmed the cop who died today listening to the teacher who got ill speak.'

c. Ben biliyorum [genç haberci-nin [yaşlı polis-in
I know young journalist-GEN old cop-GEN
[tedirgin öğretmen-in konuşmasını] dinlemesini]
agitated teacher-GEN speak listen to
görüntülediğini.]
film
'I know that the young journalist filmed the old cop listening to the agitated teacher speak.'

(Dokudan et al., 2017, p. 60)

The participants took part in a speeded acceptability judgment task in which they were asked to judge the sentences as acceptable or unacceptable. It was predicted that the absence of a missing VP2 would be less likely to be noticed in sentences with RC-modified subjects as in (69b) than in those with non-modified subjects as in (69a). The adjectival modification conditions were added to control for length and nominal modification.

The results showed that the grammatical sentences overall were judged as more acceptable than their ungrammatical version with a missing VP2. Furthermore,

the acceptability of ungrammatical sentences was higher in sentences in which the subjects were modified by RCs (76%) as in (57b) or by adjectives (73%) as in (57c) than in sentences in which the subjects were not modified (65%) as in (57a). There was no reliable difference between the RC modification condition as in (57b) and the adjectival modification condition as in (57c). Dokudan et al. concluded that the high percentage of acceptable responses for the ungrammatical sentences showed evidence for missing-VP2 illusion in Turkish 2-CE-SCs, and the illusion was stronger when the second subject whose verb was missing was involved in another dependency.

Huang and Phillips (2020) conducted a study to investigate missing-VP2 illusion in English and missing-NP illusion in Mandarin Chinese. In Mandarin doubly center-embeddings with relative clauses (2-CE-RCs) are formed with a sequence of three verbs followed by a sequence of three object NPs, and if there is any illusion due to a missing argument, that would show in missing NPs instead of missing VPs as in English. Huang and Phillips conducted two acceptability rating tasks, one in Mandarin and one in English, and ran a computational model. Their Experiment 1 examined if there was missing-NP illusion in Mandarin, and if there was, how the VPs and NPs were thematically related in the ungrammatical sentences. There were six conditions in this experiment. Two conditions tested the presence of missing-NP illusion in semantically plausible sentences by manipulating the grammaticality of the sentence (grammatical with all three NPs present as in (58a) vs. ungrammatical due to a missing final NP, *yiliangci de gongchengshi* (engineers a few times), shown via strikethrough, as in (58b)). The omitted NP in (58b) was the object of VP1 and the subject of VP2. The remaining four conditions in (58c-f) were all ungrammatical due to a missing final NP, and they examined which VPs and NPs

were thematically related in missing-NP sentences. The sentences in (58c-f) were manipulated for their plausibility such that either NP1 or NP2 would be an inappropriate argument for the VPs due to plausibility and/or animacy violations. In (58c-e) the VPs were manipulated to change the plausibility of NP2, *qiye* (corporation), as an argument (NP2 was an implausible object of VP1, *aishangle* (fell in love with), in (58c), implausible object of VP2, *aishangle* (fell in love with), in (58d) or implausible subject of VP3, *danren* (serve as), in (58e)). The sentence in (58f) manipulated the plausibility of NP1 as an argument, i.e., NP1, *jiating* (family), was an implausible object of VP3, *yanfa* (develop). In (58) the VPs and the NPs following them are numbered based on their linear order as in Huang and Phillips's (2020) study.

(58) a. Kexuejia hen xinshang pipingguo yanfa dianzichanpin
scientist very admire criticized develop electronics
VP1 VP2 VP3 NP1
yizhenzi de qiye yiliangci de gongchengshi.
a.while DE corporation a.few.times DE engineer
NP2 NP3
'The scientist admires very much the engineer who criticized a few times the corporation that has developed electronics for a while.

b. Kexuejia hen xinshang pipingguo yanfa dianzichanpin
scientist very admire criticized develop electronics
yizhenzi de qiye ~~yiliangci de gongchengshi.~~
a.while DE corporation ~~a.few.times DE engineer~~

c. Kexuejia aishangle pipingguo yanfa dianzichanpin
scientist fell.in.love.with criticize develop electronics
yizhenzi de qiye.
a.while DE corporation

d. Kexuejia xinshang aishangle yanfa dianzichanpin
scientist admire fell.in.love.with develop electronics
yizhenzi de qiye.
a.while DE corporation

e. Kexuejia xinshang pipingguo danren daxue-xiaozhang
scientist admire critized serve.as university-president
yizhenzi de qiye.
a.while DE corporation

f. Kexuejia hen xinshang pipingguo yanfa jiating yizhenzi
scientist very admire critized develop family a.while
de qiye.
DE corporation

(Huang & Phillips, 2020, pp. 15-17).

Huang and Phillips predicted that if there was missing-NP illusion in Mandarin, the plausible missing-NP sentences as in (58b) would receive higher ratings than their grammatical versions as in (58a). It was estimated for thematic relations that implausible missing-NP sentences as in (58c-f) would result in lower ratings than their plausible version as in (58b). That is, if speakers of Mandarin established certain thematic relations between NPs and VPs, the conditions which were semantically implausible for those relations as in (58c-f) would receive lower ratings than the plausible missing-NP sentence as in (58b), and the illusion would be weaker

in those sentences. For instance, if speakers interpreted NP1, *jiating* (family), as the object of VP3, *yanfa* (develop), the sentence in (58f) would receive lower ratings than the plausible missing-NP sentence as in (58b) because NP1 was an implausible object of VP3 in (58f).

The results confirmed a missing-NP illusion in Mandarin in that the plausible missing-NP sentences as in (58b) received higher ratings than their grammatical versions as in (58a). For thematic relations, all the implausible missing-NP sentences as in (58c-f) received lower ratings than the plausible missing-NP sentences as in (58b). The lower ratings for all the implausible missing-NP sentences were taken as an indication that in Mandarin missing-NP sentences, NP1 was interpreted as the object of VP3, and NP2 was interpreted as subject of VP3 and the object of both VP1 and VP2. Overall, Huang and Philips attributed the missing-NP illusion in Mandarin to the establishment of thematic relations between referents and predicates in the sentence. That is, in missing-NP sentences all the NPs were thematically related to a VP, and conversely, all the VPs had at least one NP argument.

Huang and Phillips conducted an acceptability rating experiment in English as well to investigate if missing-VP2 illusion reported in previous studies for English would be replicated; but more importantly if it did, how the NPs and VPs were thematically related in missing-VP2 sentences. Experiment 2 had four conditions manipulating the grammaticality of the sentences (grammatical with all three VPs present as in (59a), ungrammatical due to a missing VP3, *had recently fired*, as in (59b), ungrammatical due to a missing VP2, *had typed quickly*, as in (59c) or ungrammatical due to a missing VP1, *was banned by the local library,* as in (59d)). The three ungrammatical conditions in (59b-d) had plausibility manipulations to investigate the thematic relations between the NPs and VPs. In (59b) if NP3, *the*

publishing company, rather than NP2, *the horror author*, was taken as the subject of the first VP, namely VP2, *had typed quickly*, this would result in a plausibility violation and thus, lead to lower ratings. Similarly, in (59d) if the NP1, *the novel*, rather than NP2, *the horror author*, was taken as the subject of the final VP, VP2, *had typed quickly*, a plausibility violation would appear, resulting in lower ratings in this condition. But in (59c) the establishment of thematic relations between NP1, *the novel*, and the last VP, VP1, *was banned by the local library;* and NP3, *the publishing company*, and the first VP, VP1, *had recently fired*, would not result in plausibility manipulations. Note that in the ungrammatical conditions the first VP was VP2 in (59b) and VP3 in (59c-d), and the final VP was VP1 in (59b-c) and VP2 in (59d).

(59) a. The novel that the horror author who the publishing company
NP1 NP2 NP3

had recently fired had typed quickly was banned by the local library.
VP3 VP2 VP1

b. The novel that the horror author who the publishing company ~~had recently fired~~ had typed quickly was banned by the local library.

c. The novel that the horror author who the publishing company had recently fired ~~had typed quickly~~ was banned by the local library.

d. The novel that the horror author who the publishing company had recently fired had typed quickly ~~was banned by the local library~~.

(Huang & Phillips, 2020, p. 20)

Huang and Philips predicted that if missing-VP2 illusion in English 2-CE-RCs was replicated, the ungrammatical sentences due to a missing VP2 as in (59c) would receive as equal as or higher ratings than their grammatical versions as in (59a). For thematic relations, it was estimated that if NP1, but not NP2, was taken as the subject

of the last VP, and if NP3, but not NP2, was taken as the subject of the first VP, the implausible semantic relations for these interpretations would lead to lower ratings in (59b, d) than in (59c), and the implausible sentences as in (59b, d) would have a weaker illusion.

The results demonstrated that the ratings for the ungrammatical sentences with a missing VP2 as in (59c) received the highest ratings among the three ungrammatical conditions, but there was no reliable difference between the grammatical sentences as in (59a) and the ungrammatical sentences with a missing VP as in (59c). These results replicated the earlier findings by Gibson and Thomas (1999), and confirmed missing-VP2 illusion in English 2-CE-RCs. Furthermore, the lower ratings in the sentences with implausible semantic interpretations for NP1-final VP and NP3-first VP as in (59b, d) compared to the sentences with plausible semantic interpretations for such relations as in (59c) provided evidence that NP1 and NP3 were thematically related to the final and the first VPs as their subjects, respectively. Thus, Huang and Phillips concluded that as in Mandarin, all the referents, i.e., NP1, NP2 and NP3, and the verbs, i.e., the first and the last VP, were thematically related in the English sentences, and the presence of thematic relations between the referents and verbs creates a sense of completeness, leading to a grammaticality illusion in the case of missing VP2 in English and a missing NP in Mandarin.

Huang and Phillips also used Futrell et al.'s (2020) computational model (see Section 2.3 for the details of this model) to examine its predictive power for missing-VP/NP illusion in languages with different head-final properties, i.e., head-initial English and head-final German, Dutch and Mandarin. The model predicted an illusion for English but not for German, Dutch or Mandarin. Thus, although the

predictions of the model were in line with experimental data for English, German and Dutch; it predicted the opposite pattern of the experimental data for Mandarin. Thus, Huang and Philips concluded that the cross-linguistic variation regarding missing-VP/NP illusion could not be explained with head-finality, as was suggested by the experience-based accounts.

Overall, Huang and Phillips demonstrated that there was missing-VP2 illusion in English and missing-NP illusion in Mandarin, contradicting with the predictions of both the resource- (Gibson & Thomas, 1999) and experience-based accounts (e.g., Frank et al., 2016; Vasishth et al., 2010). Recall that in the resource-based account the parser is expected to forget NP2's predictions for a VP (see Section 2.2.2 for details), i.e., the VP2's predictions for an NP in the case of Mandarin. But the two post-verbal NPs in Mandarin, namely NP1 and NP2, were thematically related to the VPs in the sentence such that every VP had at least one NP argument, which would not be expected to allow the parser to forget the predictions for an NP in Mandarin. And the experience-based accounts (see Section 2.3 for details) predicted no illusion for languages with a (more) common occurrence of head-final structures, but the data showed illusion for Mandarin. Huang and Phillips concluded that their findings supported Bader's (2015) interference-based explanation for missing-VP2 illusion in that upon processing the second NP in Mandarin and the second VP in English, the syntactic similarity of the possible attachment sites (VP1 and VP2 in Mandarin, and NP1 and NP2 in English) causes similarity-based interference effects. They also extended their explanations to thematic relations hypothesis, suggesting that when all the referents and predicates are connected via thematic relations, this leads to a sense of completeness for the

sentence and results in a grammaticality illusion in the case of a missing VP2 in English and a missing NP in Mandarin.

The studies that have been discussed in this section investigated the predictions of the interference-based account for missing-VP/NP illusion in center-embedded structures. One explanation proposed in these studies was that missing-VP illusion occurs due to the similarity of the subjects NP1 and NP2 in terms of their syntactic position, which results in similarity-based interference effects in retrieving the correct subject NP for the second VP, leading the lack of a VP for NP2 to go unnoticed (Bader, 2015; Häussler & Bader, 2015; for German; Huang & Philips, 2020; for English and Mandarin). Other studies reported a role for thematic relations in missing-VP (or missing-NP) illusion. Dokudan et al. (2017) suggested, based on data from Turkish, that when the subject NPs receive thematic relations through their involvement in another syntactic dependency such as relative clause modification, the absence of VP2 would not be noticed as its subject would already be thematically related to a verb, i.e., the verb of the relative clause, which would lead to a grammaticality illusion. Huang and Philips argued, based on data from English and Mandarin, that when all the referents and predicates in a sentence were involved in thematic relations, this could create a sense of completeness for the sentence and result in a grammaticality illusion.

The present study investigates the predictions of the interference-based account on center-embedding difficulty in Turkish center-embeddings in Experiments 1 and 3 (see Chapter 3 for details). Specifically, it investigates whether or not decreasing the case similarity of the NPs facilitates the processing of Turkish center-embeddings and/or modulates missing-VP2 illusion in them. Case similarity is investigated for both syntactic and phonological case in which syntactic case refers

to the similarity of case marking on the subject NPs (the null nominative case vs. the genitive case *–(n)In*) and phonological case refers to the phonological similarity of case marking on the subject or object NPs (the genitive case *–(n)In* on either the subject NPs or on the first NP of a genitive-possessive construction serving as an object in the sentence) (see Chapter 3 for further details). Thus, in this thesis both an off-line (Experiment 1) and an on-line experiment (Experiment 3) examine the role of syntactic and/or phonological interference of the NPs in the processing of Turkish center-embeddings, and whether or not syntactic interference would modulate a potential missing-VP2 illusion in Turkish.

2.5 Prosodic phrase lengths account

Prosody has been shown to have a role at many levels of language production and language processing. Numerous studies have provided evidence that prosodic information is an important part of spoken language, and it plays a crucial role in speech production (e.g., Katz, Beach, Jenouri, & Verma, 1996; Schafer, Speer, Warren, & White, 2000; Millotte, Wales, & Christophe, 2007; Tyler, 2013). Additionally, it has been widely reported that prosodic properties of a spoken sentence may inform the listeners on its syntactic structure (e.g., Lehiste, 1973). Examine the example in (60), in which "||" marks prosodic boundaries.

(60) a. The hostess greeted || the girl with a smile.

b. The hostess greeted the girl || with a smile.

(Stageberg, 1958; as cited in Lehiste, 1973)

Uttering the sentence in (60) with the insertion of a prosodic boundary before the NP, *the girl*, as in (60a), leads to the interpretation that the PP, *with a smile*, modifies

the girl. On the other hand, when the same sentence is spoken with a prosodic boundary after *the girl* as in (60b), the PP is understood to modify the verb.

The role of spoken prosody in sentence processing has been examined and confirmed in several behavioral and electrophysiological (ERP) studies. It has been shown in the behavioral and ERP studies that prosodic information can inform listeners on the syntactic structure of the sentence (e.g., Clifton, Carlson, & Frazier, 2002, 2006; Kjelgaard & Speer, 1999; Lehiste, 1973; Price, Ostendorf, Shattuck-Hufnagel, & Fong, 1991; Schafer et al., 2000; Steinhauer, Alter, & Friederici, 1998, 1999), help them resolve ambiguities (e.g., Kjelgaard & Speer, 1999; Lehiste, 1999; Speer, Kjelgaard, & Dobroth, 1996) or could lead them towards an incorrect parse if misplaced (e.g., Kjelgaard & Speer, 1999; Pauker, Itzhak, Baum, & Steinhauer, 2011).

The role of prosody in sentence comprehension is not limited to spoken prosody, though. Fodor (2002) argues in her Implicit Prosody Hypothesis (IPH) that in reading, similar to in listening, language users mentally project prosodic boundaries onto the sentences that they read. The projected prosody in reading is predicted to be identical to the default overt prosody of a sentence and to inform the structure built for that sentence. The projected prosodic boundaries would allow the parser to divide the sentence into smaller chunks (i.e., prosodic phrases[4]). The claim that the parser forms chunks or smaller phrases in sentence processing originates in Frazier and Fodor's (1978) sausage machine model. The sausage machine model is a two-stage model of syntactic parsing. The first stage is referred to as the Preliminary Phrase Packager (PPP) and the second-stage is referred to as the Sentence Structure Supervisor (SSS). The sausage machine model maintains that the PPP divides a

[4] Fodor uses the term "prosodic phrase" to denote a unit lower in the prosodic hierarchy than a full Intonational Phrase (IPh). In the literature, the term "prosodic phrase" is also used to refer to the intermediate phrase (ip), major phrase (MaP), phonological phrase or p-phrase.

sentence into chunks to form phrasal/clausal packages, which are separated by prosodic boundaries and the SSS then combines these phrases to represent the complete structure of the sentence.

Fodor argues that three constraints determine the readers' projection of implicit prosodic boundaries: (i) the principle of congruence with the syntactic structure of the sentence, (ii) the principle of optimal phrase lengths and (iii) the principle of balanced lengths. The principle of congruence with the syntactic structure is based on the Align XP constraint of Selkirk (2000) and the Wrap constraint of Truckenbrodt (1999). Selkirk's Align XP constraint claims that "the right edge of any XP in syntactic structure must be aligned with the right edge of a major phrase (MaP) in prosodic structure" (Selkirk, 2000, p. 232), and Truckenbrodt's Wrap constraint maintains that "each syntactic XP must be contained in a phonological phrase" (Truckenbrodt, 1999, p. 10). The principle of optimal phrase lengths is associated with Selkirk's (2000) BinMin and BinMax constraints. The BinMin constraint claims that "a major phrase must consist of at least two minor/accentual phrases" (Selkirk, 2000, p. 244), and the BinMin constraint states that "a major phrase must consist of no more than two minor/accentual phrases" (Selkirk, 2000, p. 244). But the constraints on the syntax-prosody interface have been considered as "soft constraints" in the Optimality Theory, meaning that some of them can be ranked higher or be more dominant than the others in the case of a conflict. Thus, based on the principle of optimal phrase lengths, the length of an intermediate phrase (ip)[5] must be optimal depending on the prosodic properties of the language in question, and the optimal phrase length of an ip in English was argued to

[5] In the literature two levels of prosodic phrasing are assumed. Whereas Speer et al. (1996) used the terms intonational phrase (IP) and intermediate phrase (ip) to refer to these levels, Kjelgaard and Speer (1999) referred to them as intonational phrase (IPh) and phonological phrase (PPh). I will use the terms IP and ip in this thesis.

be three prosodic words (PWds)[6] (Fodor, 2013). The third principle, the principle of balanced lengths, claims that "prosodic phrasing favors balanced structures in which sister constituents are roughly equal in prosodic weight" (Fodor, 1998, p. 302). Prosodic weight is defined in terms of prosodic length. This principle is closely related to Ghini's (1993) Uniformity principle, which suggests that "a string is ideally parsed into same length units (Ghini, 1993, p. 56). The balanced lengths principle is triggered by the motive to "compromise at the interface between a flat prosodic structure and a strongly hierarchical syntactic structure" (Fodor, 1998, p. 309).

The Implicit Prosody Hypothesis (IPH) has been supported in several studies (Augursky, 2006; Bader, 1998; Harris, Jun, & Royer, 2016; Kentner, 2012; 2017; Kitagawa & Fodor, 2006; McCurdy, Kentner, & Vasishth, 2013; Quinn, Abdelghany, & Fodor, 2000; Traxler, 2009; among others), but most notably, in an ERP study by Steinhauer and Friederici (2001), in which commas in written input elicited a Closure Positive Shift (CPS) component at locations where a prosodic boundary would be projected in spoken input. Steinhauer and Friederici's findings, thus, provided evidence for a mental projection of implicit prosodic boundaries (elicitation of CPS at commas) and showed that commas in silent reading rest on the same mechanism as overt prosodic cues in listening and similarly inform the parser in its syntactic decisions.

In the case of center-embeddings, Fodor (2013) claims that the extreme difficulty in processing 2-CE-RCs is due to an incongruency between their (implicit) prosodic phrasing and syntactic structure. That is, the prosodic phrases that are created in processing 2-CE-RCs align very poorly with the deeply nested syntactic

[6] In the theory of Prosodic Phonology, a prosodic word is larger than a syllable or a foot, but smaller than a phonological phrase (e.g., Nespor & Vogel, 1986; Selkirk, 1981). Prosodic word is often defined as being the domain of word stress, phonotactics and segmental word-level rules.

structure of the sentence. Fodor suggests that the misalignment at the syntax-prosody interface can be overcome with a prosodic phrasing that is induced by optimal and balanced phrase lengths encouraging the optimal phrasing of the sentence, which can ease the processing of doubly center-embedded structures. An English 2-CE-RC contains a minimum of six PWds[7], as illustrated in (61).

(61) The woman the man the girl loved met died.

(Fodor, 2013, p. 216)

The sentence in (61) is unlikely to be phrased as a single ip given the optimum phrase length of three PWds in English. An English 2-CE-RC can, therefore, be divided into two phrases, as illustrated in (62). In (62) the phrases that do not form syntactically coherent units are underlined.

(62) a. NP1 || NP2

The woman || <u>the man the girl loved met died.</u>

b. NP1 || NP3

<u>The woman the man</u> || <u>the girl loved met died</u>.

c. NP1 || VP3

<u>The woman the man the girl</u> || <u>loved met died</u>.

d. NP1 || VP2

<u>The woman the man the girl loved</u> || <u>met died</u>.

e. NP1 || VP1

The woman the man the girl loved met || died.

(Fodor, 2013, p. 219)

For the principles of optimal and balanced phrase lengths, the only phrasing option that has optimal and balanced phrases is the phrasing of the sentence as NP1 || VP3

[7] Unstressed function words such as the determiners (e.g., *the* in (61)) are grouped together with an adjacent open-class word in forming a prosodic word. A prosodic word may, thus, contain more than one lexical item in English.

as in (62c), which has 3+3 PWds. The sentence is phrased as 1+5 PWds in (62a), 2+4 PWds in (62b), 4+2 PWds in (62d) and 5+1 PWds in (62e). But the phrasing in (62c) does not align with the syntactic structure of the sentence, which is given in Figure 3, as both of the phrases that are formed do not form coherent syntactic units.

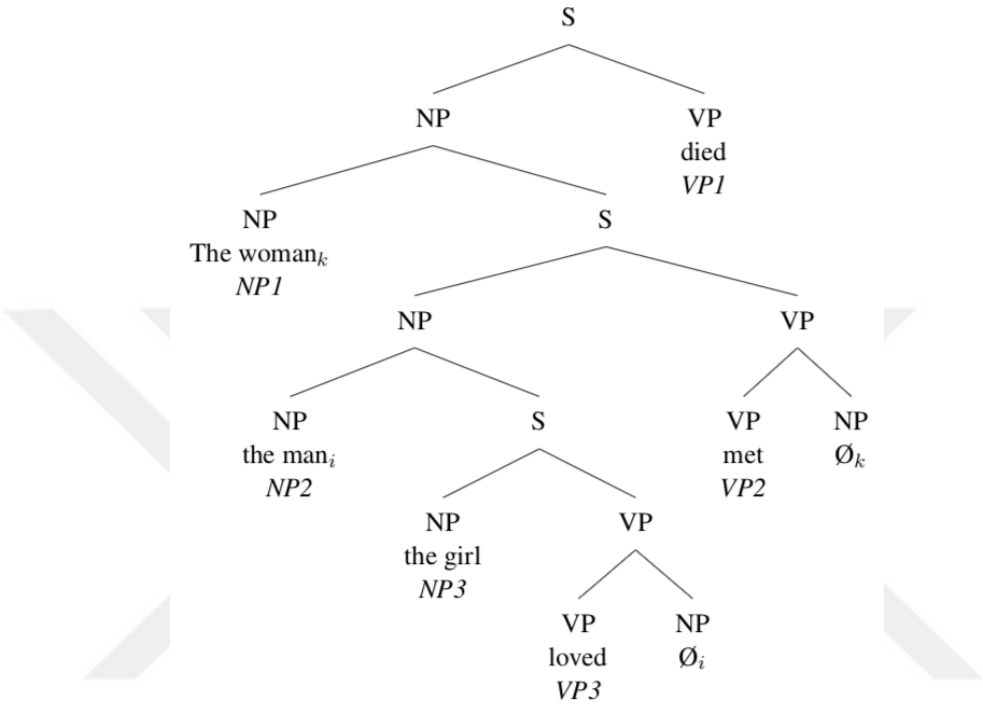


Figure 3. Surface structure of the sentence in (62)

In the phrasing in (62c), the subjects and their verbs are grouped in separate packages. There are two crucial problems with this phrasing option. The first is that the three consecutive subject NPs that are grouped together can be mistakenly interpreted as a conjoined noun phrase, as experimentally shown by Blumenthal (1966) (see Section 2.1 for a detailed discussion of Blumenthal's study). The second problem is that the grouping of three consecutive verbs does not form a coherent syntactic unit. Thus, although the phrasing in (62c) has optimal and balanced phrase lengths, it cannot be the optimal phrasing of English 2-CE-RCs as it violates the principle of syntactic coherence.

For the principle of congruence with the syntactic structure, the phrasing options in (62a-d) do not conform to the principle of alignment with the syntactic structure since the second phrase in (62a) and both of the phrases in (62b-d) are not coherent syntactic phrases. The only phrasing option in which the prosodic boundary aligns with the syntactic structure of the sentence is (62e). But this division violates the principles of optimal and balanced phrase lengths as it has an unbalanced structure of 5+1 PWds. Fodor suggests that if the length of the contributing phrases is altered such that the resulting phrases have optimal and balanced phrase lengths as in (63) below, the phrasing option in (62e) could be optimal. In the sentence in (63), VP1 is lengthened with three additional PWds, and NP1 is shortened with the use of a pronoun for NP3.

(63) The woman someone I love met || died on a cruise ship in Maine.

(Fodor, 2013, p. 219)

However, Fodor argued that unlike exceptional cases as in (63), it is quite difficult to compress the whole subject NP1 into a single ip, especially when it has three lexical NPs. Thus, Fodor claims that in order to have a prosodic phrasing of 2-CE-RCs which conform to the principles of syntactic coherence as well as optimal and balanced phrase lengths, the parser may project a second prosodic boundary inside NP1 and divide the sentence into three ips. A possible division for this could be NP1 || RC1 || VP1, as illustrated in (64).

(64) NP1 || RC1 || VP1

The elderly French woman || that the man the girl loved met || died last year in Maine.

(Fodor, 2013, p. 220)

The phrasing in (64) divides 2-CE-RCs into three phrases as NP1 || RC1 || VP1 in which NP1 and VP1 are lengthened, and RC1 is kept short to have balance across the phrases. This phrasing is compatible with the principles of optimal and balanced phrase lengths as it has the structure of 3+4+3 PWds. Moreover, Fodor argues that the phrasing of the sentence as NP1 || RC1 || VP1 as in (64) aligns with the syntactic structure of the sentence. But recall that the phrases that are combined to represent the whole sentence must be syntactic sisters. As illustrated in the surface structure on the left in Figure 4, although NP1 and VP3 are syntactic sisters, RC1 is not a syntactic sister to NP1 and VP1. Fodor argues that RC1 can be attached to NP1 as a syntactic sister through string-vacuous RC extraposition[8], as shown in in Figure 4.

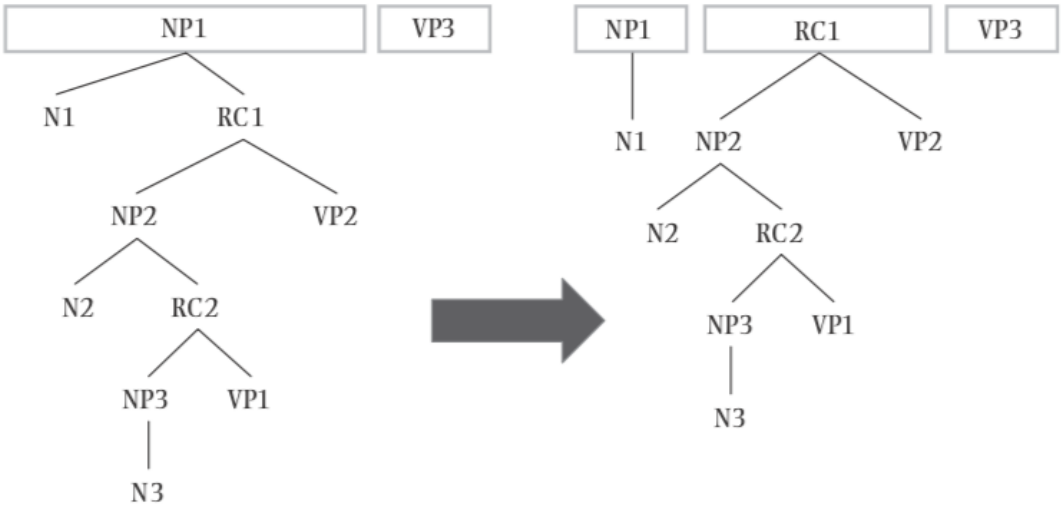


Figure 4. String-vacuous extraposition of RC1 in the doubly center-embedded construction (taken from Fodor et al., 2017, p. 162). The syntactic tree on the left shows the surface structure before the RC extraposition and the syntactic tree on the right shows the one after the RC extraposition. Note that the final VP, VP3, in this figure is labeled as VP1 in this thesis.

As the tree on the left in Figure 4 illustrates, in 2-CE-RCs the restrictive RC1 is syntactically subordinate to its head NP1 and thus, RC1 is not a syntactic sister to NP1 and VP1. But through string-vacuous extraposition, the RC is raised out of its

[8] See Chomsky and Halle (1968) and Wagner (2010) for a detailed explanation of string-vacuous RC extraposition in English.

subordinate position and becomes a sister to its head as shown in the tree on the right. This upward movement is possible due to an anaphoric link between the RC and its head that encodes their semantic relationship. That is, with extraposition, the RC1 becomes a sister to NP1, which enables RC1 and NP1 to be phrased as two separate prosodic phrases, and then combined as syntactic sisters.

Thus, Fodor maintains that the phrasing of the sentence as NP1 || RC1 || VP1 as in (64) is the optimal phrasing for 2-CE-RCs, in which NP1 and VP1 are lengthened enough to stand on their own, and RC1 is prosodically light enough to have a balanced structure across the contributing phrases. This phrasing conforms to the principle of optimal and balanced phrase lengths and the principle of congruence with the syntactic structure of the sentence.

Fodor also argues that the phrasing of the sentence as NP1 || RC1 || VP1 is the optimal phrasing for 2-CE-RCs since chunking the structure into more phrases is counterproductive. For instance, since RC1, *that the man the girl loved met* in (64), is structurally too complex and may not always fit into a single ip, the parser may project an additional prosodic boundary inside RC1 to divide it into two phrases. A possible phrasing with such an additional prosodic boundary is NP1 || RC1 || VP2 || VP1, as illustrated in (65). In the sentence in (65) RC1 is divided further to form a separate phrase for VP2, and VP2 is lengthened to 3 PWds to form a prosodic phrase on its own and to have balanced phrases across the sentence, i.e., 3+3+3+4 PWds.

(65) NP1 || RC1 || VP2 || VP1

The elderly French woman || that the man the girl loved || met on Mediterranean cruise || died last year in Maine.

(Fodor, 2013, p. 222)

Although this additional phrase of VP2 is expected to decrease the syntactic complexity of RC1, Fodor argues that the VP2 || VP1 sequence does not improve the processing of the sentence as it is not congruent with the syntactic structure. That is, RC1 and VP2 are not syntactic sisters; and thus, they cannot be combined as separate ips. The only VP that can be a sister to NP1 and RC1 is VP1.

Fodor's (2013) prosodic phrase lengths account also offers an explanation for missing-VP2 illusion. In Fodor's account, missing-VP2 illusion is attributed to the separation of VP2 as a different phrase. That is, whereas a non-optimal phrasing would make the parser less likely to detect the absence of a missing VP2, the optimal phrasing of the sentence as NP1 || RC1 || VP1 is predicted to lead to lack of illusion. The sentence in (66) does not have the optimal phrasing, i.e., NP1 || RC1 || VP1, since it does not have NP1 and VP1 lengthened, and RC1 is not shortened to fit into a single ip. A possible prosodic phrasing of the sentence in (66), thus, may be NP1 || RC1 || VP2 || VP1, a non-optimal prosodic phrasing.

(66) The ancient manuscript || that the graduate student who the new card
NP1 RC1

catalog had confused a great deal || was studying in the library ||
VP2

was missing a page.
VP1

(Gibson & Thomas, 1999, p. 237)

In grammatical 2-CE-RCs that are non-optimally phrased and have VP2 phrased separately as in (66), upon processing VP2 the parser attaches VP2 as a syntactic sister to NP1 and RC1, and VP2 can be mistakenly interpreted as the predicate of the sentence. But at VP1, it is discovered that VP1 is the predicate of the sentence, leaving no attachment site for VP2. In this phrasing, VP2 cannot be phrased into RC1 as the parser does not revise the structure of phrases that are processed earlier.

In ungrammatical 2-CE-RCs with a missing VP2, the absence of VP2 goes unnoticed (since there is no attachment site for it), resulting in a grammaticality illusion. But in English 2-CE-RCs that are optimally phrased as NP1 || RC1 || VP1, the absence of VP2 is predicted to be noticed since the correct syntactic structure of sentence is more likely to be built in these sentences.

The following two sections report on the studies that were conducted to test the predictions of the prosodic phrase lengths account for center-embedding difficulty and missing-VP2 illusion, respectively.

2.5.1 Prosodic phrase lengths account on center-embedding difficulty

Fodor and Nickels (Fodor & Nickels, 2011; Fodor et al., 2017) conducted a rating task followed by a production task to investigate whether the phrasing of English 2-CE-RCs as NP1 || RC1 || VP1 had a facilitative role in their processing. To encourage or discourage the optimal phrasing of the sentence as NP1 || RC1 || VP1, they manipulated both phrase lengths as in (67) and prosodic weight of the contributing phrases as in (68). For phrase lengths, in the sentences encouraging the optimal phrasing of sentence as NP1 || RC1 || VP1 as in (67a) the outer phrases of NP1 and VP1 were lengthened, and RC1 was kept short to form a relatively balanced structure across the three phrases while in those discouraging the optimal phrasing of the sentence as NP1 || RC1 || VP1 as in (67b), NP1 and VP1 were kept short and RC1 was lengthened. For prosodic weight, in the sentences encouraging the optimal phrasing as in (68a), less predictable words such as *soufflé* in NP1 and *disintegrated* in VP1 were used whereas in those discouraging the optimal phrasing as in (68b), more predictable words such as *drink* in NP1 and *spilled* in VP1 were used. Less predictable words as in (68a) were predicted be less prone to phonetic reduction and

prosodically heavier and thus, more likely to form separate prosodic phrases of their own. The experimental sentences were presented in a familiarization procedure and were built up in five steps to increase the overall comprehensibility of the sentences, as exemplified for the conditions manipulating the phrase lengths as in (67).

(67) a. My dad trained a plumber.

Here is the plumber my dad trained.

The plumber my dad trained fixed the rusty old ceiling pipes.

Here are the rusty old ceiling pipes that the plumber my dad trained fixed.

The rusty old ceiling pipes || *that the plumber my dad trained fixed* || *continue to leak occasionally.*

b. The new janitor reluctantly assisted an unlicensed plumber.

Here is the unlicensed plumber the new janitor reluctantly assisted.

The unlicensed plumber the new janitor reluctantly assisted tried to repair the pipes.

Here are the pipes that the unlicensed plumber the new janitor reluctantly assisted tried to repair.

The pipes || *that the unlicensed plumber the new janitor reluctantly assisted tried to repair* || *burst.*

(Fodor et al., 2017, p. 149)

(68) a. The soufflé that the waitress the boss hired brought disintegrated.

b. The drink that the hostess the nightclub employed stirred spilled.

(Fodor et al., 2017, p. 147)

The participants were asked to read both the preceding sentences and the target sentence (in italics in (67-68)) silently for comprehension, then read the target

sentence aloud for recording. After reading the sentences out loud, they would rate them for pronounceability and comprehensibility on separate scales. The sentences that were encouraged to be optimally phrased as NP1 || RC1 || VP1 as in (67a-68a) were expected to receive higher ratings and have the expected prosodic breaks in the optimal phrasing.

Both pronounceability and comprehensibility ratings showed that the sentences that are encouraged to be phrased optimally received higher ratings than those that were discouraged to be phrased optimally when phrasing was manipulated with phrase lengths as in (67), but not when manipulated with prosodic weight as in (68). This provided evidence that English 2-CE-RCs that were encouraged to be optimally phrased with phrase lengths were perceived to be more pronounceable and more comprehensible. Two trained judges analyzed the production data for the locations of prosodic boundaries in the sentences. Three types of sentence prosody patterns were of interest: (i) integration of VP2 into RC1, (ii) separation of VP2 from RC1 and (iii) no break before VP1. The third pattern where there was no break before VP1, was found to be uncommon in general. Whereas integration of VP2 into RC1 was found to be more common in the sentences that were encouraged to be optimally phrased with phrase lengths as in (67a), separation of VP2 from RC1 was found to be more common in the sentences that were discouraged to be optimally phrased with phrase lengths as in (68b). Further analyses were conducted to examine the relationship between the phrasing patterns and comprehensibility ratings. Those analyses showed that the comprehensibility ratings for the items where VP2 and RC1 were phrased together were higher than those for the items in which VP2 was phrased separately. These findings suggested evidence that inclusion of VP2 in RC1

as expected in the optimal phrasing facilitates the processing of English 2-CE-RCs, as was predicted by the prosodic phrase lengths account.

Fodor et al. (2019) conducted a study to investigate when prosodic phrasing that was manipulated with stress pattern of the sentence affected the processing of English 2-CE-RCs. They carried out a production task employing a new methodology, i.e., *double reading* paradigm. In this paradigm, the participants were asked to read aloud the sentences first with no preview, and then with a full preview. The difficulty that was observed in the first reading was predicted to reflect an on-line performance challenge that resulted from dealing with various uncertainties in the sentence, but if there were still significant difficulties in the second reading, that was argued to imply a processing difficulty that was inherent to the center-embedded structures. The participants were presented with sentences in which each of NP1, NP2, VP1 and VP2, and the innermost clause of NP3 and VP3 as a whole had two words that can be stressed as in (69). Unlike the earlier experiments investigating phrase lengths effects (Fodor & Nickels, 2011; Fodor et al., 2017), the experimental stimuli in this study was designed not to bias the participants towards a certain prosodic pattern. This was because in the previous experiments phrase lengths were manipulated with additional words, which may have changed the lexical/semantic content of the sentences across the conditions. In this experiment, it was argued that the stress patterns of the NPs and VPs could be used to phrase the sentence as optimally or non-optimally such that the NPs and VPs could be produced with one, two or even neither of the stressable items carrying stress.

(69) [The red glitter [that the greeting cards [that the kids made]
NP1 NP2 NP3 VP3

were covered in] got everywhere.]
VP2 VP1

(Fodor et al., 2019, p. 17)

The produced prosodic pattern of the sentences was evaluated as the dependent measure because it was argued to indicate the processing difficulty of the sentences based on earlier findings by Fodor et al., (2017) (see above). That is, the more the sentences were produced with the optimal phrasing, the easier they were predicted to be comprehended. The sentences were predicted to have the expected prosodic breaks in the optimal phrasing of the sentence as NP1 || RC1 || VP1 more often in the second reading after preview than in the first reading.

The evaluation of the produced prosodic pattern of the sentences by three trained judges showed that the optimal pattern was overall more often produced both for NP and VP sequences in the second reading than in the first reading. A further investigation of individual differences in phrasing preferences demonstrated that whereas some participants benefited from preview and were able to project the optimal phrasing in the second reading, others did not show improvement. Thus, Fodor et al. concluded that while preview may help some speakers with the on-line processing difficulties of English 2-CE-RCs and enable them to better process the structure, some speakers had deeper problems in processing the structure, which was not eased with preview.

The studies that have been reviewed in this section provided evidence that English 2-CE-RCs that were encouraged to be optimally phrased as NP1 || RC1 || VP1 by optimal and balanced phrase lengths were perceived to be easier to pronounce and comprehend than those that were discouraged to phrased optimally

(Fodor & Nickels, 2011; Fodor et al., 2017), and the optimal phrasing could better ease the processing of English 2-CE-RCs when the sentences were read with preview than when they were read without preview (Fodor et al., 2019). The next section discusses a study testing the predictions of the phrase lengths account for missing-VP2 illusion.

2.5.2 Prosodic phrase lengths account on missing-VP2 illusion

Fodor and colleagues (Schott and Fodor, 2013; Fodor et al., 2017) maintained that missing-VP2 illusion in 2-CE-RCs could be explained with reference to the prosodic phrasing of the structure. They argued that the parser was more likely to notice the lack of a missing VP2 in 2-CE-RCs if the phrasing of the sentence discourages the optimal phrasing of 2-CE-RCs as NP1 || RC1 || VP1. Schott and Fodor (Fodor et al., 2017; Schott & Fodor, 2013) investigated whether or not the prosodic phrasing of 2-CE-RCs would modulate missing-VP2 illusion. They conducted a production task followed by a judgment task. The experiment had four conditions manipulating phrase lengths (encouraging as in (70a-b) vs. discouraging optimal lengths for the optimal phrasing of the sentence as NP1 || RC1 || VP1 as in (70c-d)) and grammaticality of the sentence (grammatical with all three VPs present as in (70a, c) vs. ungrammatical due to missing VP2 as in (70b, d)). In the sentences that encouraged the optimal phrasing as in (70a-b), NP1 and VP1 were lengthened, and in the sentences that discouraged the optimal phrasing as in (70c-d) NP1 and VP1 were kept too short to stand on their own and RC1 was lengthened so that it did not form a single phrase. To control for overall sentence length, the omitted VP2 in the ungrammatical conditions as in (70b, d) was replaced with additional adverbs that were placed at the beginning of the sentences.

(70) a. The rusty old ceiling pipes || that the plumber my dad trained fixed || continue to leak occasionally.

b. Admittedly, the rusty old ceiling pipes || that the plumber my dad trained ~~fixed~~ || continue to leak occasionally.

c. The pipes || that the unlicensed plumber the new janitor kindly assisted tried to repair || still leak.

d. To no-one's surprise, the pipes || that the unlicensed plumber the new janitor kindly assisted ~~tried to repair~~ || still leak.

(Fodor et al., 2017, p. 20-21)

The participants were asked to read the experimental stimuli first silently, and then aloud for recording. After the recording, they were asked to judge whether something was missing from the sentence. Schott and Fodor predicted that the sentences encouraging the optimal phrasing as in (70a) would be perceived to be easier than those discouraging the optimal phrasing as in (70c). It was also estimated that it would be easier to detect the absence of VP2 in the sentences encouraging the optimal phrasing as in (70b) than those discouraging the optimal phrasing as in (70d).

The results showed that the participants accurately detected the presence or absence of VP2 in all four conditions (>79%). These results failed to replicate the missing-VP2 illusion observed in previous studies on English (Gibson & Thomas, 1999; Christiansen & MacDonald 2009). Further analyses showed for the grammatical sentences that the sentences encouraging the optimal phrasing as in (70a) were more often judged as complete, i.e., not missing something, than those discouraging the optimal phrasing as in (70c). Moreover, for the ungrammatical sentences, the participants were more likely to notice the lack of a missing VP2 in

the sentences encouraging the optimal phrasing as in (70b) than in those discouraging the optimal phrasing as in (70d). Although the results confirmed Fodor's (2013) prediction that the detection of a missing VP2 would be easier when the sentences were encouraged to be phrased optimally, the participants were overall very likely to detect the missing VP2. Schott and Fodor attributed the absence of missing-VP2 illusion to three reasons: (i) the explicitness of the question which directly asked whether something was missing from the sentence, (ii) web-based methodology, which may have enabled the participants to study the sentences at length before answering the question or (iii) reading the sentences aloud, which might have led to deeper syntactic processing than the silent reading methodology in earlier studies.

The production data were examined by two trained judges for the produced prosody. These analyses showed that phrase length manipulations influenced the prosodic contour of the sentences, especially in the region of subject NPs. The two prosodic patterns that were of primary interest were (i) the presence of a break after NP1 and (ii) the presence of a break after NP2. Whereas the former was considered to be helpful for the optimal phrasing of NP1 || RC1 || VP1, the latter was considered to discourage the optimal phrasing. The results showed that the sentences encouraging the optimal phrasing as in (70a-b) were more often pronounced with breaks after NP1 while the sentences discouraging the optimal phrasing as in (70c-d) were more often produced with breaks after NP2. These results confirmed that the optimal phrasing for English 2-CE-RCs could be NP1 || RC1 || VP1 in that whereas a prosodic break after NP1 helped processing, a prosodic break after NP2 did not. The participants' judgments for the missing VP2 was further analyzed in relation with the produced prosody. These analyses showed that when participants produced the

sentences with a break after NP2, which was considered to discourage the optimal phrasing, the participants' judgments for the absence of VP2 was less accurate. This provided evidence that the optimal phrasing increased the comprehensibility of the sentences. Overall, the results of Schott and Fodor's study showed that prosodic phrase lengths that encouraged the optimal phrasing of the sentence as NP1 || RC1 || VP1 eased processing and enabled the parser to build the correct structure of the sentence, which, in turn, led to an easier detection of a missing VP2 in the sentence.

The studies by Fodor and colleagues (Fodor & Nickels, 2011; Fodor et al., 2017; Schott & Fodor, 2013) have demonstrated that English 2-CE-RCs that were optimally phrased as NP1 || RC1 || VP1 could be processed more easily than those with a non-optimal phrasing. The easier processing with the optimal phrasing presumably makes the parser more likely to build the correct syntactic structure of the 2-CE-RCs, as was revealed by the increased rates of detecting the missing VP2 in Schott and Fodor' (2013) study.

The current study investigates whether a relatively balanced prosodic phrasing of Turkish 2-CE-RCs, viz., NP1 || NP6 || VP1, that is induced by prosodic phrase lengths would ease the processing of the structure, and whether or not such a prosodic phrasing would modulate a potential missing-VP2 illusion. Turkish is typologically different from English. Thus, a further manifestation of the prosodic phrase lengths account in Turkish 2-CE-RCs could contribute to the cross-linguistic generalizability of the phrase lengths account for center-embedding difficulty. The present study investigates these questions via an acceptability judgment task (Experiment 2) and an eye-tracking experiment (Experiment 3). The eye-tracking experiment is predicted to shed light on the real-time effects of phrase lengths on 2-CE-RCs. Moreover, Experiment 3 examines the effects of syntactic and phonological

interference manipulated with case similarity and phrase lengths in a single design using eye-tracking methodology. There have been several studies supporting both case interference (see Section 2.4) and phrase lengths (see Section 2.5), but these studies were conducted in separate designs. The examination of case interference and phrase lengths together using eye-tracking methodology (Experiment 3 of the present study) would allow to test the time-course of case interference and phrase lengths effects, whether or not one factor influences the processing of the construction sooner than the other, whether or not the two factors interact and whether or not one factor influences the final interpretation of the construction more than the other.

Chapter 3 presents the details of the three experiments in the present study.

CHAPTER 3

THE PRESENT STUDY

This study investigates the extreme processing difficulty that is associated with Turkish center-embedded sentences. As was discussed in detail in Chapter 2, several accounts have been proposed to explain the difficulty of center-embedded structures. Two of these accounts are tested in the present study. One is the interference-based account which maintains that decreasing the similarity among the NPs (in terms of their syntactic, phonological, positional and/or semantic features) may ease the difficulty of center-embeddings (e.g., Lewis & Vasishth, 2005; Lewis et al., 2006). The other is the prosodic phrase lengths account which states that when optimally phrased, center-embedded sentences are easier to process and optimal phrasing can be encouraged by manipulating the lengths of the contributing phrases (Fodor, 2013).

Recall from Chapter 2 that the processing of center-embeddings is so difficult that the omission of the second verb (VP2) from the sentence has been reported to be unnoticed, resulting in a grammaticality illusion. The interference-based account attributes missing-VP2 illusion to similarity-based interference effects that arise in retrieving the correct subject NP for VP1, the final VP (Bader, 2015; Haussler & Bader, 2015). The phrase lengths account, however, maintains that missing-VP2 illusion is observed if the sentence is not optimally phrased (Fodor, 2013). The present study, thus, also tests the predictions of interference-based and prosodic phrase length accounts for missing VP2 illusion in center-embedded sentences. Since the study language is Turkish, two other accounts are relevant for the investigation of missing-VP2 illusion. It has been argued that missing-VP2 illusion is modulated by the headedness properties of a language, and the illusion does not exist in verb-final

languages such as Turkish (Vasishth et al., 2010; Frank & Ernst, 2018; Frank et al., 2016). This was discussed as the experience-based account in Chapter 2. However, it has been argued elsewhere (the resource-based account) that the illusion should be cross-linguistic as it is due to forgetting the predictions of VP2 as a result of high memory overload (Gibson & Thomas, 1999). The predictions of the resource-based and experience-based accounts are therefore also tested in the investigation of the missing-VP2 illusion in Turkish center-embedded sentences.

The specific questions that are addressed in this thesis are as follows: (i) do the interference-based and/or prosodic phrase lengths accounts explain the processing difficulty associated with center-embedded structures in Turkish; (ii) is there a missing-VP2 illusion in Turkish, a head final language; and (ii) do syntactic and phonological case similarity and/or prosodic phrase lengths modulate a (potential) missing-VP2 illusion in Turkish? Three experiments, two off-line acceptability judgment experiments and an eye-tracking experiment, are conducted to investigate these questions.

Experiments 1 and 2 employ acceptability judgment tasks, and they test whether or not a missing-VP2 illusion exists in Turkish center-embeddings. Experiment 1 tests the predictions of the interference-based account (i.e., effects of syntactic interference) for missing-VP2 illusion as well as its predictions for the perceived difficulty of center-embedded structures. Experiment 2 investigates the predictions of the phrase lengths account for missing-VP2 illusion as well as its predictions for the perceived difficulty of center-embedded structures. The predictions of the resource-based and experience-based accounts are also tested in Experiments 1 and 2. End-of-sentence acceptability judgments are often defined as *a reported perception of acceptability* (Schütze, 1996; Sprouse & Almeida, 2012).

Judgment data are especially valuable for the investigation of missing-VP2 illusion since they enable us to make inferences about the cognitive systems, including the grammatical system of human language faculty (Schütze & Sprouse, 2014).

Experiment 3 examines the real-time effects of interference (i.e., syntactic and phonological interference) and prosodic phrase lengths in processing center-embedded sentences in Turkish. It employs eye-tracking methodology which can inform on both early and later cognitive processes that take place as language users process linguistic stimuli (Rayner, Sereno, Morris, Schmauder, & Clifton, 1989). Eye-tracking methodology also enables us to observe reading in an experimental setting as natural as possible (Duyck, Van Assche, Drieghe, & Hartsuiker, 2007), especially when compared to other methodologies such as self-paced reading.

3.1 Center-embedded structures in Turkish

Recall from Chapter 2 that in English, a head-initial language, doubly center-embedded structures with relative clauses (2-CE-RCs) are formed with two object relative clauses (RCs) which are nested in one another, as shown in (1). In the examples in this chapter, including (1), brackets ([]) show clause boundaries, the arrows at the top show subject-verb relations, and the arrows at the bottom show verb-object relations.

(1) [The rat [$_{RC1}$ the cat [$_{RC2}$ the dog chased] ate] died.]

NP1 NP2 NP3 VP3 VP2 VP1

Each of the RCs in the English 2-CE-RC in (1) defines one of the first two subject NPs. That is, in the sentence in (1), RC2 *the dog chased* modifies the subject NP2,

the cat, and RC1 *the cat … ate* modifies the subject NP1, *the rat.* Both the NP1, *the rat,* and the NP2, *the cat,* take two different argument roles: (i) the subject of the predicate of its clause and (ii) the object of the predicate of the lower clause.

In head-final languages, such as Turkish, various center-embedding constructions are possible. A center-embedding construction may include sentential complements or relative clauses with argument extraction. These two types of center-embeddings can be roughly schematized as in (2) where (2a) illustrates a doubly center-embedding with sentential complements (2-CE-SC) and (2b) illustrates a doubly center-embedding with relative clauses (2-CE-RC) ("_" shows a gap of an extracted argument).

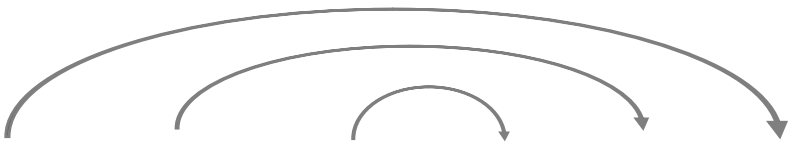
(2) a. 2-CE-SC: $[NP_1\ [NP_2\ [NP_3\ V_3]\ V_2]\ V_1]$

b. 2-CE-RC: $[NP_1\ [[NP_2\ [[NP_3\ _\ V_1]\ NP_4]\ _\ V_2]\ NP_5]\ V_1]$

(Uehara, 2003, p. 25)

In 2-CE-SCs as in (2a), the complement clauses are the objects of the verbs, and they are nested in between the subjects and their predicates, as illustrated with a Turkish example in (3). In (3a), CP2 *öğrencinin ağladığını* (that the student cried) is the object of VP2, *gördüğünü* (saw), and CP1, *müdürün … gördüğünü* (that the principal … saw), is the object of VP1, *biliyor* (knows). The glosses and the translation for the example are presented in (3b).

(3)



a. [Öğretmen [$_{CP1}$ müdürün [$_{CP2}$ öğrencinin ağladığını] gördüğünü] biliyor.]

NP1 NP2 NP3 VP3 VP2 VP1

b. Öğretmen-Ø müdür-ün öğrenci-nin

teacher-NOM principal-GEN student-GEN

ağla-dığ-ı-nı gör-düğ-ü-nü

cry-VN-3SG.POSS-ACC see-VN-3SG.POSS-ACC

bil-iyor-Ø

know-PROG-3SG

'The teacher knows that the principal saw that the student cried.'

(Dokudan et al., 2017, p. 60)

A simplified surface structure for the sentence in (3) is shown in Figure 5:

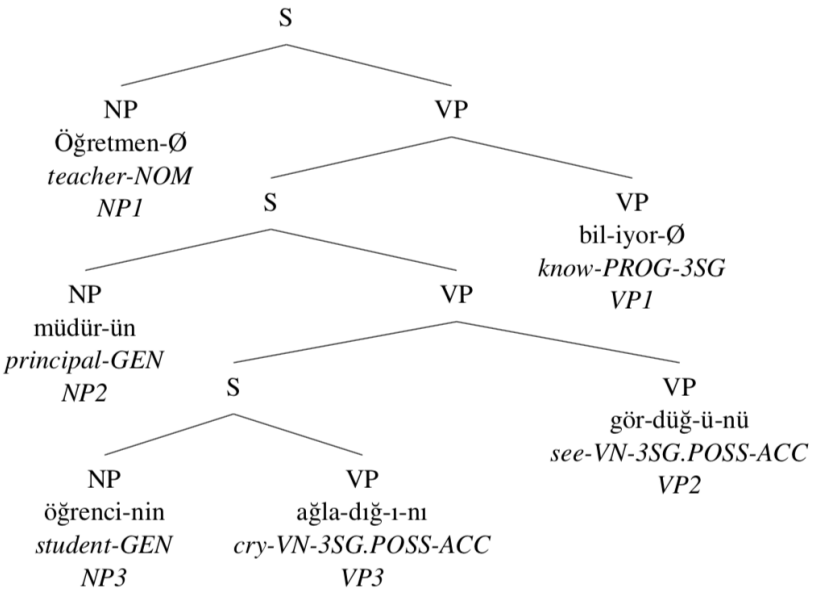
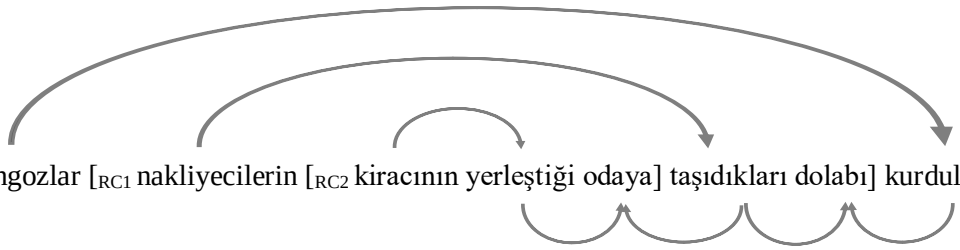


Figure 5. Surface structure of the Turkish 2-CE-SC in (3)

In 2-CE-RCs as in (2b) there are two object relative clauses that are nested in one another, as shown in (4).

(4)

a.



b. Marangoz-lar-Ø nakliyeci-ler-in kiracı-nın yerleş-tiğ-i
carpenter-PL-NOM mover-PL-GEN tenant-GEN settle-PART-3SG.POSS
oda-ya taşı-dık-ları dolab-ı kur-du-lar
room-DAT move-PART-3PL.POSS closet-ACC set.up-PF-3PL
'The carpenters set up the closet that the movers placed in the room where the tenant moved.'

Unlike the English 2-CE-RCs as in (1) where the RCs define the subject NPs, in the Turkish 2-CE-RC as in (4) above each of the two RCs define separate object NPs. RC2 *kiracının yerleştiği* (where the tenant settled) modifies the object NP4, *oda-ya* (room-DAT), and *odaya* functions both as the direct object of VP3, *yerleş-tiğ-i* (settle-PART-3SG.POSS), and as the indirect object of the ditransitive VP2, *taşı-dık-ları* (move-PART-3PL.POSS). RC1 *nakliyecilerin ... taşıdıkları* (that the movers moved) modifies the object NP5, *dolab-ı* (closet-ACC), and *dolab-ı* (closet-ACC) functions both as the direct object of VP1, *kur-du-lar* (set.up-PF-3PL), and as the direct object of the ditransitive VP2, *taşı-dık-ları* (move-PART-3PL.POSS). So, similar to the subject NP1 and NP2 in English 2-CE-RCs, the object NP4 and the object NP5 in Turkish 2-CE-RCs have two different arguments roles: (i) the object of the predicate of its clause and (ii) the object of the predicate of the lower clause. A simplified surface structure of the sentence in (4) is presented in Figure 6.

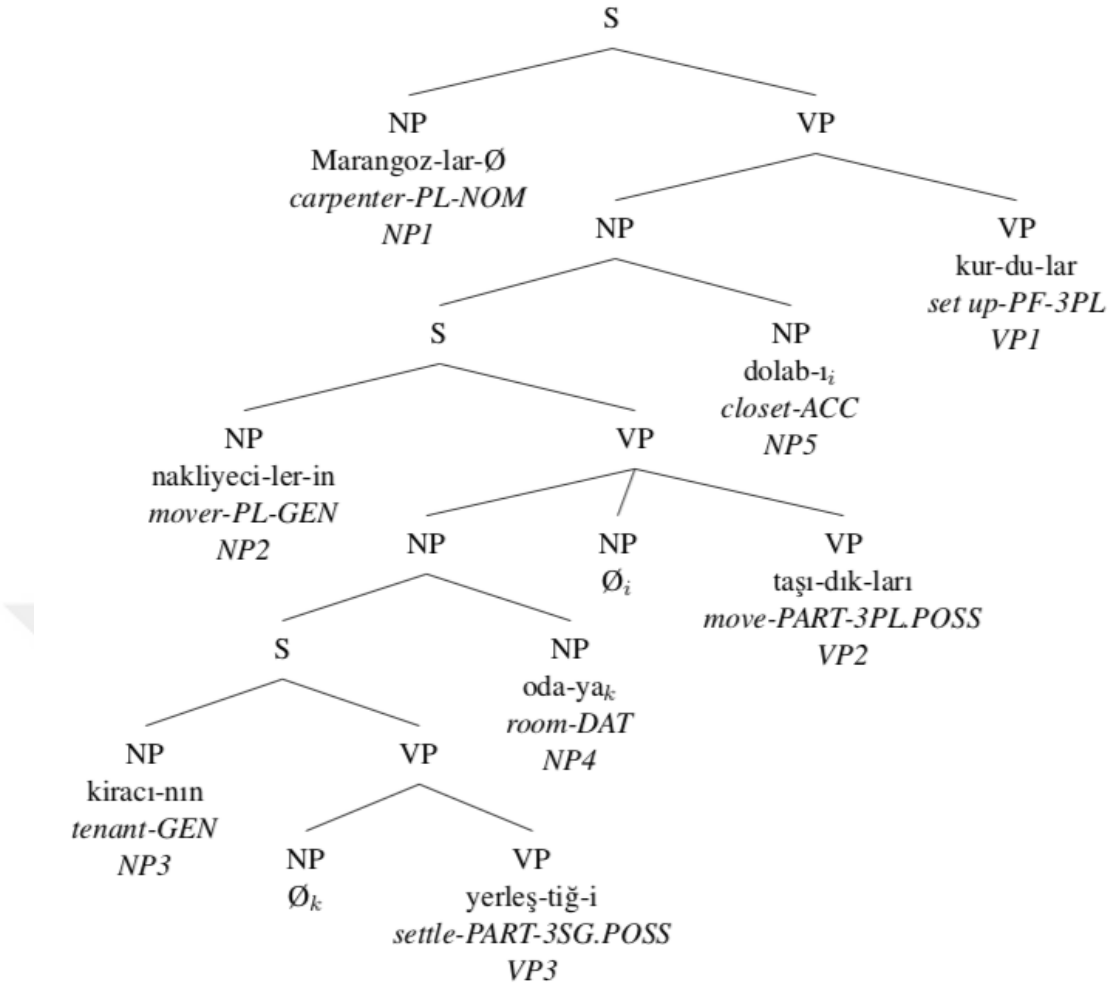


Figure 6. Surface structure of the Turkish 2-CE-RC in (4)

Unlike 2-CE-RCs which exist in both head-initial and head-final languages, 2-CE-SCs are available only in head-final languages. Most of the previous studies on the processing of center-embeddings in head-final languages employed 2-CE-SCs as their experimental stimuli (Lewis & Nakayama, 1999; 2002; Nakayama et al., 2005; Uehara, 2003; Uehara & Bradley, 1996 for Japanese; Nakayama et al., 2005; Uehara & Bradley, 1996 for Korean; Vasishth, 2003 for Hindi; Dokudan et al., 2017 for Turkish; see Chapter 2 for the details of these studies) presumably because in their surface form they allow for sentential complements to be placed in between subjects and predicates in the form of [NP1 [NP2 [NP3 VP3] VP2] VP1], which is the same surface structure of 2-CE-RCs in head-initial languages such as English and French (Uehara, 2003). But the present study employs 2-CE-RCs in Turkish because

structurally 2-CE-RCs in Turkish seem to be more comparable than 2-CE-SCs to the 2-CE-RCs in head-initial languages. Similar to the 2-CE-RCs in head-initial languages, Turkish 2-CE-RCs contain filler-gap dependencies for the extracted object relative clauses. And as in 2-CE-RCs in head-initial languages, the two relativized NPs in Turkish 2-CE-RCs as in (4), namely NP4 and NP5, have "double functions" (Bever, 1970). That is, NP4 and NP5 receive two theta roles by two different verbs while all the NPs in Turkish 2-CE-SCs as in (3) have only one theta role. Thus, for a more robust comparison of the Turkish data to the previous literature on center-embedded constructions in head-initial languages, the present study employed 2-CE-RCs as experimental sentences.

There are two important points to note about the 2-CE-RCs in Turkish. First, while the NPs with double functions are NP1 and NP2 in English, the NPs with double functions are NP4, *oda-ya* (room-DAT), and NP5, *dolab-ı* (closet-ACC), in Turkish. The difference is due to the headedness properties of the two languages. While the relative clauses follow the NPs that they modify in English, a head-initial language; they precede the NPs that they modify in Turkish[9], a head-final language (Erguvanlı, 1984; Göksel & Kerslake, 2005). When the RCs define the subject NP1 and NP2, in Turkish 2-CE-RCs, the sequence of three consecutive subjects at the beginning of the sentence is interrupted by the RCs that precede them, as illustrated in (5).

(5) [$_{RC1}$ Çalış-an marangoz-lar [$_{RC2}$ çağır-dığ-ım
work-PART carpenter-PL call-PART-1SG.POSS
nakliyeci-ler-in [kiracı-nın …]]]
mover-PL-GEN tenant-GEN

[9] In Turkish all RCs precede the NPs that they modify, with the exception of *ki* clauses, which are borrowed from Persian and have a very limited usage in Turkish (Göksel & Kerslake, 2005).

In the sentence in (5a) RC1 *çalış-an* (work-PART) modifies and precedes the subject NP1, *marangoz-lar-Ø* (carpenter-PL-NOM), and RC2 *çağır-dığ-ım* (call-PART-1SG.POSS) modifies and precedes the subject NP2, *nakliyeci-ler-in* (mover-PL-GEN). Thus, the positioning of the RCs before their head NPs prevents the occurrence of three consecutive NPs in center-embedded structures. That is, the structure in (5) does not have the consecutive occurrence of three subject NPs in the surface form as in the 2-CE-RCs in head-initial languages such as English. Thus, the 2-CE-RC constructions as presented in (4) are employed in the present study as they appear to match the processing difficulty associated with 2-CE-RCs in head-initial languages.

Second, the VP2s in Turkish 2-CE-RCs are ditransitive verbs, unlike their English transitive counterparts. That is, the ditransitive VP2 in (4), *taşı-* (to move), takes two objects: (i) the relativized object of VP3: NP4, *oda-ya* (room-DAT), and (ii) the object of VP1 which is relativized by VP2: NP5, *dolab-ı* (closet-ACC). Due to use of a ditransitive VP2 Turkish 2-CE-RCs have an additional object NP4, *oda-ya* (room-DAT). Ditransitive verbs are necessary so as to have the RCs nested in the structure. That is, when a transitive VP2, e.g., *gör-düğ-ü-nü* (see-PART-3SG.POSS-ACC), is used in Turkish center-embeddings, a second RC cannot be nested in the structure, as illustrated in (6).

(6) [Marangoz-lar [$_{SC}$ nakliyeci-ler-in [$_{RC}$ kiracı-nın
carpenter-PL mover-PL-GEN tenant-GEN
yerleş-tiğ-i oda-yı]
settle-PART-3SG.POSS-ACC room-ACC
gör-düğ-ü-nü] bil-iyor-lar.]
see-VN-3SG.POSS-ACC know-PROG-3PL
'The carpenters know that the movers saw that the tenant settled in the room.'

In the sentence in (6) the RC *kiracının yerleştiği* (where the tenant settled) modifies and precedes the object NP *oda-yı* (room-ACC), and the modified object NP *kiracının yerleştiği odayı (the room in which the tenant settled)* receives the direct object role from VP2, *gör-düğ-ü-nü* (see-PART-3SG.POSS-ACC). Since RCs precede the heads that they modify in Turkish, a second object that would follow VP2 is needed so as to have a second RC in the structure. Thus, a transitive VP2 prevents the presence of two nested RCs in the doubly center-embedded structures in Turkish. Since doubly center-embedded structures with only one nested RC as in (6) would not be as equally complex as 2-CE-RC structures in head-initial languages, a ditransitive VP2 is used in forming the Turkish 2-CE-RC structures in the present study.

3.2 Experiment 1: Acceptability judgment task testing syntactic interference effects and missing-VP2 illusion

Experiment 1 investigated whether or not syntactic interference manipulated via case markings modulated the perceived difficulty of Turkish center-embeddings, whether or not missing-VP2 illusion existed in Turkish center-embeddings, and whether or

not syntactic interference modulated the existence of missing-VP2 illusion. Experiment 1 also tested whether or not syntactic interference affected the processing difficulty of Turkish center-embeddings in general. Recall from Chapter 2 that the interference-based account states that decreasing the similarity of subject NPs in terms of their case similarity eases the processing difficulty of center-embedded structures as it would help their differentiation and the retrieval of the correct subject NPs while processing their verbs. In the interference-based account, presence of two similar subject NPs, the first and the second NPs, would lead to a stronger missing-VP2 illusion. This experiment tests the predictions of the similarity-based interference account in Turkish center-embeddings in relation to both missing-VP2 illusion and general processing difficulty of center-embeddings.

Also recall from Chapter 2 that the resource-based account predicts cross-linguistic missing-VP2 illusion in center-embedded sentences as the illusion is attributed to forgetting the memory predictions of VP2 due to working memory limitations of cognitive resources (Gibson & Thomas, 1999), whereas the experience-based accounts do not predict an illusion in verb-final languages such as Turkish due to more robust working memory predictions for upcoming verbs (Vasishth et al., 2010) or more frequent occurrence of verb-final structures in these languages (Frank & Ernst, 2018; Frank et al., 2016). This experiment also tests the predictions of these two accounts for the existence of missing-VP2 illusion in Turkish center-embeddings.

Following Frank and Ernst (2018), Gibson and Thomas (1999) and Huang and Phillips (2020), Experiment 1 (and also Experiment 2) employed an end-of-sentence (off-line) acceptability judgment task.

3.2.1 Participants

Eighty native speakers of Turkish (number of females = 48) participated in Experiment 1. The participants' age ranged between 18 and 32 (*M* = 23.44, *SD* = 3.25). All of the participants were native speakers of Turkish. All participation in the study was voluntary, and informed consent was obtained before data collection (see Appendix A for Ethics Committee Approval). Before the experiment, the participants were asked to fill out a background questionnaire which elicited information on demographics and language history (see Appendix B). The participants were naïve to the purpose of the study.

3.2.2 Materials

Experiment 1 had four conditions, manipulating Grammaticality (i.e., missing-verb; grammatical: Gra and ungrammatical: Ungra) and Syntactic Interference (high syntactic interference: HighInt and low syntactic interference: LowInt), as illustrated in (7a-b) below. For grammaticality, VP2, *taşı-dık-ları* (move-PART-3PL.POSS), was removed in the ungrammatical conditions (7a-b), but it was present in the grammatical conditions (7a-b). For syntactic interference, all three subject NPs, NP1, NP2 and NP3, were marked with the genitive case *–(n)In*[10,11] in the high syntactic interference conditions as in (7a), while only the subjects NP2 and NP3 were marked with the genitive case *–(n)In* in the low syntactic interference conditions as in (7b). In (7) subjects and their verbs are in the same color and case marking is in bold face.

[10] Turkish is a vowel harmony language. When a suffix is attached to a stem, the vowels in the suffix harmonize with those in the preceding syllable of the stem in terms of their frontness and roundedness features. In this thesis capital letters are used to indicate the vowels that are subject to vowel harmony rules.

[11] In Turkish vowels do not occur next to one another. When a suffix beginning with a vowel is attached to a stem ending in a vowel, either the initial vowel of the suffix is deleted as in the case of the first person possessive suffix *-(I)m*, or the buffer consonant *y* is added as in the case of the accusative case marker *–(y)A* (Göksel & Kerslake, 2005). The genitive case marker *–(n)In*, which has a deletable initial *n*, is an exception to this rule (Göksel & Kerslake, 2005).

VP2s that were omitted in the ungrammatical conditions are crossed out and additional adjectives in parentheses replaced the omitted verbs in the ungrammatical conditions. Note that in the experimental materials of Experiment 1 (and also in Experiments 2 and 3) the NPs and VPs in the 2-CE-RCs structure are numbered based on their subject-verb dependencies. The matrix verb of the sentence and its null subject are not included in this numbering.

(7) a. HighInt, Gra/Ungra

Ø	[Marangoz-lar-**ın**	[nakliyeci-ler-**in**	[kiracı-**nın**	gri
Pro	carpenter-PL-GEN *NP1-GEN*	mover-PL-GEN *NP2-GEN*	tenant-GEN *NP3-GEN*	gray
koltuğ-**u**	yerleştir-diğ-i]		oda-ya	
sofa-ACC *NP4-ACC*	place-PART-3SG.POSS *VP3*		room-DAT *NP5*	
taşı-dık-ları/ ~~taşıdıkları~~]		(ahşap)	dolab-ı	
move-PART-3PL.POSS *VP2*		wooden	closet-ACC *NP6*	
kur-duk-ları-nı]		zaten	bil-iyor-um.	
set.up-VN-3PL.POSS-ACC *VP1*		already	know-PROG-1SG	

b. LowInt, Gra/Ungra

Ø [Marangoz-lar-**Ø** [nakliyeci-ler-**in** [kiracı-**nın**

Pro carpenter-PL-NOM mover-PL-GEN tenant-GEN
NP1-NOM *NP2-GEN* *NP3-GEN*

koltuğ-**un** minder-leri-ni yerleştir-diğ-i]

sofa-GEN cushion-3PL-ACC place-PART-3SG.POSS
NP4-GEN *NP5* *VP3*

oda-ya taşı-dık-ları/ ~~taşıdıkları~~] (ahşap) dolab-ı

room-DAT move-PART-3PL.POSS wooden closet-ACC
NP6 *VP2* *NP7*

kur-du-lar] diye bil-iyor-um.

set.up-PF-3PL.POSS SUB know-PROG-1SG
VP1

'I (already) already know that the carpenters set up the (wooden) closet that the movers moved/ ~~moved~~ to the room where the tenant placed the gray sofa.'

The experimental stimuli in Experiment 1 (and also in Experiments 2 and 3) employed 2-CE-RCs as in (4) (see above) that are nested as a noun clause inside a matrix clause. This was necessary for the case interference manipulation on the first subject NP, *marangoz-lar(-ın)* (carpenter-PL(-GEN)). (Note that I will use the term center-embedding for the present study materials.)

The syntactic interference manipulation in (7) is available thanks to differential marking of subjects in finite and non-finite embedded clauses in Turkish (Göksel & Kerslake, 2005). In the present study, finite embedded were noun clauses, and non-finite embedded clauses were object RCs. Thus, the discussion here focuses only on these two types of finite and non-finite embedded clauses (see Göksel & Kerslake (2005) for a thorough discussion of embedded clause types in Turkish).

Finite embedded clauses are identical in structure to a matrix clause and are formed through a subordinator, e.g., *diye* in (7b). That is, the subject of the finite embedded clause is marked with the null nominative case marker, and the embedded verb receives the same inflectional suffixes, i.e., voice suffixes, the negative marker, tense/aspect/modality markers, copular markers and person markers, as a finite matrix clause verb (Göksel & Kerslake, 2005). In non-finite embedded clauses such as object RCs and noun clauses, the subject receives the genitive case marker *-(n)In*, and the verb receives the possessive suffix *-(s)I* after being marked with the factive nominal *-DIK*[12], as in (7a). The possessive marker on the embedded verb is then followed by person and case markers, giving the non-finite clause a genitive-possessive structure.

The differential case marking on the subjects of finite and non-finite embedded clauses were used to manipulate syntactic interference among the subject NPs in the present study. In the high syntactic interference conditions as in (7a) the 2-CE-RC structure was a non-finite noun clause, in which the subject NP1 and its verb VP1 had a genitive-possessive construction. That is, NP1, *marangoz-lar-ın* (carpenter-PL-GEN), was in genitive case marking and the nominalized VP1, *kur-duk-ları-nı* (set.up-VN-3PL.POSS-ACC), had the possessive marker. In the low syntactic interference conditions as in (7b), on the other hand, the 2-CE-RC structure was a finite noun clause, in which the subject NP1, *marangoz-lar-Ø* (carpenter-PL-NOM), received the null nominative case and its verb, VP1, *kur-du-lar* (set.up-PF-3PL), had the past tense marker and person agreement. In both high and low syntactic interference conditions as in (7a-b) the embedded clauses including NP2-VP2 and NP3-VP3 also had the structure of a genitive-possessive construction. That

[12] In Turkish consonants assimilate to the voicing features of the preceding and following sounds. In this thesis consonants that are subject to voicing assimilation are shown in capital letters.

is, the subjects NP2, *nakliyeci-ler-in* (mover-PL-GEN), and NP3, *kiracı-nın* (tenant-GEN) in (7a-b), were marked with genitive case marking, and their verbs VP2, *taşı-dık-ları* (move-PART-3PL.POSS), and VP3, *yerleştir-diğ-i* (place-PART-3SG.POSS), in (7a-b), had a possessive suffix and agreement morphology. Thus, in the high syntactic interference conditions as in (7a) all three overt subject NPs, NP1, NP2 and NP3, were in genitive case marking while in the low syntactic interference conditions as in (7b) NP1 was in null nominative case marking, decreasing the number of genitive-case-marked subject NPs from three to two.

Note that in Turkish the genitive case marking *–(n)In* has two functions: it marks (i) the subject of a non-finite embedded clause and (ii) the first modifier noun in a genitive-possessive construction. This was used to control for phonological similarity across the high interference and low syntactic interference conditions. In the low syntactic interference conditions, the first object NP, NP4, *koltuğ-un* (sofa-GEN), in (7b), was marked with genitive case and was followed by NP5, *minder-leri-ni* (cushion-3PL.POSS-ACC), forming a genitive possessive construction (*sofa's cushions*). This brought up the number of genitive case inflection also to three in the low interference conditions and controlled for phonological case repetition across the high interference and low syntactic interference conditions (three consecutive NPs marked with genitive case *-(n)In* in both conditions). This would control for the potential extraneous factor of phonological similarity and would allow us to attribute any difference between the two conditions only to syntactic interference among the subject NPs. Note that including an object NP, NP4, marked with genitive case, required use of a ditransitive VP3, *yerleştir-diğ-i* (place-PART-3SG.POSS) in (4). Moreover, VP1, *kur-duk-ları-nı* (set.up-VN-3PL.POSS-ACC), in (7a) or *kur-du-lar* (set.up-PF-3PL), in (7b), was always optionally ditransitive so that a low rating in the

ungrammatical conditions was not a result of an argument structure violation in the form of a transitive verb taking two objects.

In the low syntactic interference conditions there was a subordinator, *diye* in (7b), due to the use of non-finite embedded clauses. In the high syntactic interference conditions an additional adverb, *zaten* (already) in (7a), was inserted in place of the subordinator *diye* before the matrix verb to control for overall sentence length across the high and low syntactic interference conditions. Moreover, to control for overall sentence length across the grammatical and ungrammatical conditions, an additional adjective, *ahşap (wood),* was inserted in place of the omitted verb in the ungrammatical conditions.

Following Christiansen and MacDonald (2009), Frank and Ernst (2018), Gibson and Thomas (1999), Gimenes et al. (2009) and Huang and Phillips (2020), in the experimental stimuli of Experiment 1 (and also of Experiments 2 and 3) each verb had strong semantic/pragmatic restrictions so that only one of the NPs were plausible as their subjects. There were two reasons to include semantic support between the subject NPs and their verbs. The first was to the ease the processing of the already difficult structure. (Recall from Chapter 2 that discriminable semantic links between the subjects and their verbs eased the processing of the extremely difficult center-embeddings (Bever, 1970; Hudson, 1996; Stolz, 1967).) The second was that semantic support between the subjects and their verbs prevents other plausible combinations of subjects and verbs. Thus, when one verb is omitted from the sentence, it is semantically evident which subject NP is left without a verb. Without semantic support between subjects and verbs, we would not be able to tell which of verbs was actually perceived missing from the sentence (Frank & Ernst, 2018).

Several measures were taken to prevent potential ambiguities in the experimental sentences in Experiment 1 (and also in Experiments 2 and 3). First, the subject NP1 and its predicate VP1[13] were marked plural. NP1 was marked for plurality to eliminate a noun compound reading for NP1 and NP2 in the low syntactic interference conditions as in (7b). In Turkish bare noun compounds such as *marangoz nakliyeci-ler* (carpenter mover-PL) can be formed with two juxtaposed nouns, which do not have any suffixation, marking the relation between them (Göksel & Kerslake, 2005). Marking NP1 with plurality eliminated a bare noun compound reading for NP1 and NP2 in the low interference conditions. Additionally, the subject NP2 and its predicate VP2 were also marked with plural marker (i) to prevent the reading of VP2 as an event of NP3 and (i) to keep the number marking across NP1 and NP2 constant. In Turkish 2-CE-RCs NP3 could be interpreted as the subject of both VP3 and VP2. This interpretation is possible with a null (*pro*) subject of VP2 that is coindexed with NP3 as illustrated in (8). In (8) both NP2 and NP3, and their predicates VP2 and VP3 are singular. That is, NP3, *kiracı-nın* (tenant-GEN), is followed by two singular VPs, VP3, *yerleştir-diğ-i* (place-PART-3SG.POSS), and VP2, *taşı-dığ-ı* (move-PART-3SG.POSS), that can be its predicate due to their number agreement and a null (*pro*) subject. This interpretation would lead NP2 to be left without attachment to any VP in the sentence. In order to force the interpretation of NP2 as the subject of only VP2, and the interpretation of NP3 as the subject of VP3; NP2 and NP3, and VP2 and VP3 were differentially marked for number. While NP3 and VP3 were marked singular, NP2 and VP2 were marked plural. Moreover, in the present study, the interference effects are investigated for syntactic interference

[13] In Turkish in sentences in which there is an overt subject NP with a plural marker the plural marking of the predicate is optional (Göksel & Kerslake, 2005). Specifically, the plural marking of the predicate is optional but common in the case of specific human subjects. In the experimental material in Experiment 1 (and also Experiments 2 and 3) the plural marking on VP1 and VP2 is used as a strategy to prevent potential ambiguities that are discussed above.

by manipulating the case similarity between NP1 and NP2. Since NP1 was already plural-marked (see above for details), the plural marking on NP2 would allow to manipulate the similarity between NP1 and NP2 only in terms of case marking.

(8) Marangoz-lar nakliyeci-nin kiracı-nın$_i$ …
carpenter-PL mover-GEN tenant-GEN
NP1-PL NP2-SG NP3-SG
yerleştir-diğ-i …*Pro*$_i$… taşı-dığ-ı…
place-PART-3SG.POSS move-PART-3SG.POSS
VP3-SG VP2-SG
kur-du-lar.
set.up-PF-3PL
VP1-PL

Furthermore, the first object NPs in both conditions, NP4 in the high syntactic interference conditions as in (7a) and NP4 and NP5 (the genitive-possessive NP) in the low syntactic interference conditions as in (7b), were always inanimate to increase the likelihood of an object reading for the first object NPs in the sentences (Traxler, Morris, & Seely, 2002).

There were twenty-four experimental sentence sets, each of which consisted of four conditions as illustrated in (7) above (see Appendix C for the full list of experimental stimuli). The experimental sentences were distributed across four lists controlling for grammaticality (grammatical vs. ungrammatical) and syntactic interference (high syntactic interference vs. low syntactic interference). The experimental sentences were combined with thirty-six filler items. The length of the filler items was comparable to those of experimental sentences. To successfully disguise the experimental sentences, twelve of the fillers were structurally similar to

the experimental sentences, but they included at most two levels of embeddings (cf. three levels of embedding in the experimental sentences); hence, they were less complex than the experimental items. Following Christiansen and MacDonald (2009), Dokudan et al. (2017), Frank and Ernst (2018) and Huang and Phillips (2020), twelve of the filler items were ungrammatical to disguise the ungrammatical missing-VP2 sentences. The ungrammaticality in these sentences was due to active-passive misalignment, number disagreement or wrong case marking. The remaining twelve filler items included sentences which were structurally less complex. They were included to increase participants' confidence in their ratings (see Appendix D for the full list of filler items). In each list the proportion of ungrammatical sentences was 40%. All the sentences in each list (including fillers) were followed by a statement whose truth value would be judged by the participants as "yes" or "no" response. 50% of the responses required a "true" response, and the other 50% required a "false" response. Following Frank et al. (2016) and Vasishth et al. (2010), comprehension statement for the experimental items were designed to include information about four different subject-verb relations, e.g., NP1-VP1, NP1-VP3, NP3-VP1 or NP3-VP3, as shown in (9) (see Appendix C for the full list of comprehension questions for each experimental stimuli). As in Frank et al.'s (2016) study, none of the comprehension questions were about the second verb (VP2) to prevent attention to the missing VP2 in the ungrammatical conditions. Comprehension statements were distributed across four lists, and each sentence was followed by one of these questions.

(9) a. *NP1-VP1:* Marangozlar dolabı kurdu.

'The carpenters set up the closet.'

b. *NP1- VP3:* Marangozlar koltuğu yerleştirdi.

‘The carpenters placed the sofa.’

c. *NP3-VP1:* Kiracı dolabı kurdu.

‘The tenant set up the closet.’

d. *NP3-VP3:* Kiracı koltuğu yerleştirdi.

‘The tenant placed the sofa.’

3.2.3 Procedure

The experiment was conducted on an on-line platform, IbexFarm (created by Alex Drummond). The participants were asked to rate the sentences on a scale of 1 (unacceptable) to 5 (acceptable). A continuous scale of acceptability was chosen based on the argument that judgments of grammaticality occur on a continuum, especially in the case of ungrammaticality (Lakoff, 1973; Ross, 1972; as cited in Schütze, 2016)[14].

At the beginning of the list, the participants were presented with three *anchors*, i.e., rated exemplary sentences, to help ensure that every participant uses the scale in a similar way, i.e., to minimize scale bias (Schütze & Sprouse, 2014). One of the rated exemplary sentences was ungrammatical, providing an anchor for the lowest point of the scale; another was an easy grammatical sentence, providing an anchor for the highest point; and the last one was an anchor for the midpoint. They were also presented with three practice sentences with different levels of acceptability before the main task to help them become familiar with the task and the scale. As was described in the Materials section above, each sentence, including the fillers, was followed by a comprehension question which required a binary response

[14] See Schütze (2016, pp. 63-70) for a detailed discussion on the view that there are gradations for (un)grammaticality.

(true or false) to a statement about the sentence that they just read. The participants did not receive any feedback on their accuracy for the comprehension questions. Experimental and filler sentences were presented in a pseudo-randomized fashion such that no two experimental items were adjacent. The task took approximately 20-25 minutes to complete.

3.2.4 Predictions

Experiment 1 tested three questions: (i) does syntactic interference manipulated via case markings influence the processing of Turkish 2-CE-RCs, (ii) is there missing-VP2 illusion in Turkish center-embeddings, and (iii) does syntactic interference modulate missing-VP2 illusion. Predictions for these questions are outlined below.

The interference-based account for center-embedding difficulty maintains that the point of maximal difficulty in processing 2-CE-RCs is the second verb due to similarity-based interference effects that arise in retrieving the correct subject NP for VP2. The presence of two possible subject NPs, namely NP1 and NP2, may result in the incorrect retrieval of the subject NP1 for VP2 in grammatical 2-CE-RCs, which would result in increased processing difficulty at the final verb, VP1. Therefore, decreasing the similarity of the target subject NPs is argued to increase the processability of center-embedded structures since it eases the retrieval of the correct subject NPs for verbs. Types of similarity that have been investigated for center-embedding difficulty in Experiment 1 are syntactic (and possibly phonological) similarity. As discussed in Chapter 2, increasing the dissimilarity of the subject NPs in terms of their syntactic (Lewis & Nakayama, 1999; 2002; Uehara & Bradley, 1996; Uehara, 2003), and/or phonological features (Nakayama et al., 2005; Vasishth, 2003; but cf. Uehara & Bradley, 1996) eases the difficulty of center-embedded

structures. In Experiment 1 for syntactic similarity the number of genitive-case-marked subject NPs was manipulated: there were two subject NPs with genitive case in the low syntactic interference conditions as in (7b) and three subject NPs with genitive case in the high syntactic interference conditions as in (7a). In the high syntactic interference conditions the subjects NP1 and NP2, both marked with genitive case, are available for retrieval at VP2. In the low syntactic interference conditions the subjects were less similar: the subject NP1 was marked with the null nominative case and the subject NP2 was marked with the genitive case; thus, only subject NP2 would be available for retrieval for VP2. If interference effects due to syntactic similarity increase the difficulty of Turkish center-embeddings, the sentences in the high syntactic interference conditions would receive lower ratings than those in the low syntactic interference conditions. For phonological similarity, the number of genitive-case-marked (subject or object) NPs was kept constant across the high syntactic interference conditions as in (7a) and the low syntactic interference conditions as in (7b). So, if phonological interference, rather than syntactic interference, influences the processing difficulty of Turkish center-embeddings, the sentences in the high and low syntactic interference conditions would receive equal ratings.

As was first noted by Janet Fodor and highlighted by Lyn Frazier (1985), 2-CE-RCs with a missing second verb are observed to be regarded as equally acceptable as or more acceptable than their grammatical versions with all three verbs present. This observation was confirmed in English (Frank & Ernst, 2018; Gibson & Thomas, 1999; Christiansen & McDonald, 2009; Vasishth et al., 2010) and French (Gimenes et al., 2009). The resource-based account attributes missing-VP2 illusion to language independent memory limitations. That is, at points of high complexity

syntactic predictions with the most memory overload, i.e., the predictions of the second verb in 2-CE-RCs, will be forgotten, leading to a grammaticality illusion (Gibson & Thomas, 1999). The experience-based accounts, on the other hand, claim that experience with language-specific properties may modulate the presence of missing-VP2 illusion (Frank & Ernst, 2018; Frank et al., 2016; Vasishth et al., 2010). That is, in experience-based accounts languages with verb-final structures may be less susceptible to the missing-VP2 illusion because of the more frequent occurrence of verb-final structures or because predictions for upcoming verbs need to remain more active; which would allow the users of these languages detect any missing verb more easily. The predictions of the experience-based accounts have been confirmed in German (Engelmann &Vasishth, 2009; Vasishth et al., 2010), Dutch (Frank & Ernst, 2018; Frank et al. 2016) and Hindi (Husain & Bhatia, 2018), all of which have verb-final structures in subordinate clauses unlike the head-initial languages such as English and French. If the predictions of the experience-based accounts are correct, then in Turkish, which is verb-final in both matrix and subordinate clauses, missing verbs would be detected more easily. This would result in the grammatical center-embeddings as in (7a-b) to receive higher ratings than the ungrammatical center-embeddings with a missing second verb as in (7a-b). But if missing-VP2 illusion is a language-independent phenomenon as was argued by the resource-based account, then the ungrammatical center-embeddings with a missing-VP2 as in (7a-b) would receive higher ratings than or equal ratings as the grammatical center-embeddings as in (7a-b).

For missing-VP2 illusion, the interference-based account predicts that missing-VP2 illusion is more likely to occur when the retrieval of the correct subject NP is negatively affected by similarity-based interference. If the predictions of

interference-based account are correct for syntactic similarity effects on the subjects, the participants would be more vulnerable to the illusion in the high syntactic interference condition as in (7a) and rate them higher than those in the low syntactic interference conditions as in (7b). If the predictions of interference-based account are correct for phonological similarity effects, the participants' vulnerability to illusion would be the same in the high and low syntactic interference conditions.

3.2.5 Data Analysis

All the statistical analyses in this thesis, including those for Experiment 1, were conducted using the statistics software R (R Development Core Team, 2020). In Experiment 1 the acceptability ratings given on a scale of 1 to 5 (acceptable) were recorded for each participant and item. Following Frank and Ernst (2018) and Huang and Phillips' (2020) analyses, ratings in Experiment 1 (and also in Experiment 2) were analyzed with cumulative link models for ordinal regression with the R package *ordinal* (Christensen, 2018).

The data were analyzed with mixed effects regression models (Bates, Maechler, Bolker & Walker, 2015). Mixed effects regression models allow us to take into account by-subject and by-item variance simultaneously (Baayen, 2008). In the analyses, random slopes for subjects and/or items by the predictor variables were also included when the model allowed to do so (Barr, Levy, Scheepers, & Tily, 2013).

Analyses were first conducted with a single predictor (Grammaticality or Case Interference), followed by complex models which included both predictors, and then followed by complex models which involved an interaction of the two predictors. Log-likelihood ratio tests were employed for model comparisons. The

complex model which included the two predictors together and the complex model which included the interaction of the two predictors were compared to simpler models that included only one of the two predictors. The most complex model which had a significantly improved fit to the data was considered to be the best fitting model. In all these model building steps, the alpha level was set to .05 in deciding on the best fitting model.

3.2.6 Results

The data inclusion criterion for the participants was 60%. The average comprehension accuracy of nine participants on experimental and filler items combined was below 60%; thus, they were excluded from the analyses. The overall comprehension accuracy of the remaining seventy-one participants was 74% on average, confirming that they were actively reading the stimuli for comprehension.

The main analyses were run on the acceptability ratings. Grammaticality and Syntactic Interference were included as fixed effects (the predictor variables); subjects and items were included as random effects. Syntactic Interference had two levels; High Syntactic Interference as in (7a) and Low Syntactic Interference as in (7b). Grammaticality had two levels; Grammatical as in (7a-b) and Ungrammatical as in (7a-b). Following Frank, Ernst, Thompson, and Cozjin (2019), the predictor variables were sum-coded: the ungrammatical conditions were coded as -0.5, and the grammatical conditions were coded as 0.5; the high interference conditions were coded as -0.5 and the low interference conditions were coded as 0.5. This coding aids in the interpretation of the estimated coefficients; a positive sign indicates higher ratings for the grammatical and the low interference conditions, whereas a negative sign indicates lower ratings for the ungrammatical and the high interference

conditions. In all the following analyses, the models included random slopes for subjects and items by the predictor variables.

Before the main analyses, to reveal longitudinal effects of familiarization or fatigue (i.e., the gradual change in the ratings due to familiarization or tiredness), the relationship between the ratings and Trial number was examined (Baayen, 2008; Baayen, Davidson, & Bates, 2008). An analysis for the relationship between the ratings and Trial number showed that Trial number was a significant predictor (β = .009, *SE* = .003, z = 3.69, $p < .001$) and therefore, it was also included as a predictor in the main analyses.

Table 1 shows the mean and standard error (in parentheses) values for the acceptability ratings in Experiment 1.

Table 1. Mean and Standard Errors (in Parentheses) for Acceptability Ratings in Experiment 1

	High Syntactic Interference	Low Syntactic Interference
Grammatical	2.86 *(.05)*	2.59 *(.05)*
Ungrammatical	2.48 *(.08)*	2.40 *(.08)*

Analyses with Grammaticality as a predictor showed that the ratings for the sentences in the Grammatical conditions as in (7a-b) were higher than those in the Ungrammatical conditions as in (7a-b) (β = .36, *SE* = .17, z = 2.15, $p < .05$). Similarly, analyses with Syntactic Interference as a predictor showed that the participants rated the sentences in the Low Syntactic Interference conditions as in (7b) significantly lower than those in the High Syntactic Interference conditions as in (7b) (β = -.40, *SE* = .13, z = -3.04, $p < .01$).

The complex model with the two predictors (Grammaticality and Syntactic Interference) explained the data better than the simple model with Syntactic Interference as a predictor variable ($\chi 2$ (1) = 14.53, $p < .05$). In order to understand

the nature of the interaction between the Grammaticality and Syntactic Interference predictors, the data were split and the effects of (un)grammaticality was examined in each High and Low Syntactic Interference conditions individually. In the High Syntactic Interference conditions, the sentences in the Grammatical condition were rated significantly higher than those in the Ungrammatical condition (β = .54, *SE* = .22, z = 2.45, p < .05). In the Low Syntactic Interference conditions, there was no reliable difference between the ratings of the sentences in the Grammatical and Ungrammatical conditions (β = .14, *SE* = .22, z = .67, p = .50).

The results showed the pattern in Table 2 below.

Table 2. Acceptability Rating Pattern in Experiment 1, ">" indicates better ratings at alpha level of .05, and "=" indicates no significant difference in ratings.

	High Syntactic Interference	Low Syntactic Interference
Grammaticality	Grammatical > Ungrammatical	Grammatical = Ungrammatical

Analyses for the filler items showed that the grammatical fillers (*M* = 4.56, *SE* = .03) received significantly higher ratings than the ungrammatical fillers (*M* = 2.47, *SE* = .05) (β = 4.47, *SE* = .34, z = 13.12, p < .001).

Although comprehension questions were designed to check for reading comprehension rather than to provide evidence for theoretical issues, following Vasishth et al. (2010), for completeness, I report on the participants' accuracy in the comprehension questions. Table 3 presents average comprehension accuracies in each condition.

Table 3. Average Comprehension Accuracy in Experiment 1

	High Syntactic Interference	Low Syntactic Interference
Grammatical	79%	77%
Ungrammatical	74%	57%

Analyses with Grammaticality demonstrated that the participants' accuracy in the Grammatical conditions was higher than that in the Ungrammatical conditions (β = .54, *SE* = .19, *z* = 2.79, *p* < .01); but their accuracy in the High and Low Syntactic Interference conditions were not statistically different (β = -.39, *SE* = .22, *z* = -1.78, *p* = .07).

The complex model with the interaction of the two predictors explained the data significantly better than the complex model including both predictors ($\chi 2$ (1) = 22.40, *p* < .01). In order to understand how the Grammaticality and Syntactic Interference predictors may have contributed to the data in the complex model with two predictors, the data were split ,and the effects of (un)grammaticality was examined in each High and Low Syntactic Interference conditions individually. In the High Syntactic Interference conditions, there was no reliable difference between the participants' accuracy in the Grammatical and Ungrammatical conditions (β = .17, *SE* = .29, *z* = .59, *p* = .55), but in the Low Syntactic Interference conditions the participants had higher accuracy in the Grammatical condition than in the Ungrammatical condition (β = .92, *SE* = .29, *z* = 3.15, *p* < .01).

3.2.7 Discussion

Experiment 1 explored if there was missing-VP2 illusion in Turkish center-embeddings, and if syntactic interference among the subject NPs that is manipulated with case similarity influenced the processing of Turkish center-embeddings and/or modulated the missing-VP2 illusion. There were three main findings: (i) contra the predictions, the center-embeddings with more syntactic similarity among the subject NPs, i.e., the high syntactic interference conditions, received higher ratings than those with less syntactic similarity, i.e., the low syntactic interference conditions; (ii)

the overall ratings for the grammatical center-embeddings in Turkish were higher than those for their ungrammatical counterparts with a missing VP2, suggesting that overall there was no missing-VP2 illusion in Turkish; (iii) there was a missing-VP2 in the sentences with low syntactic interference but not in those with high syntactic interference.

The results of Experiment 1 demonstrated that Turkish center-embeddings in the high syntactic interference conditions received higher ratings than those in the low syntactic interference conditions. This contradicts with the predictions of similarity-based interference, which anticipated lower ratings for the high syntactic interference conditions in the presence of syntactic interference effects, or equal ratings between the high and low syntactic interference conditions in the presence of phonological interference effects. This unpredicted facilitative effect of syntactic similarity in Turkish center-embeddings can be because judgment (i.e., off-line) data may reveal only limited effects of case interference. In a previous study on case interference in number attraction by Avetisyan, Lago, and Vasishth (2020), while on-line reading data showed effects of similar/distinctive case marking, off-line data, i.e., accuracy on a forced-choice task, demonstrated null effects of case interference (Avetisyan, Lago & Vasishth, 2020). So, it is likely that case interference effects may be more robust in on-line processing than in off-line processing. But, note that Avetisyan et al.'s study presented null results for case interference effects, unlike Experiment 1 of the present study which showed a significant main effect of case interference and in the opposite direction. Thus, although it is a possibility that the off-line methodology of Experiment 1 may have obscured case interference effects, the reversed pattern of results in Experiment 1 requires explanation.

The reverse pattern in the data in Experiment 1 could alternatively be due to the inclusion of sentences with non-factive inference. Recall from Section 3.2.2 that in the high syntactic interference conditions the 2-CE-RC structures were embedded as a non-finite noun clause inside a matrix clause while in the low syntactic interference conditions they were embedded as a finite noun clause inside a matrix clause with the subordinator *diye*. In Turkish with certain attitude verbs such as *bil-* (to know / believe) or *hatırla-* (to remember)[15], the factivity inference may depend on the syntactic form of the embedded clause that complement these verbs (Özyıldız, 2017). If these verbs take nominalized embedded clauses as their complement (e.g., the high syntactic interference conditions as in (7a)) the verbs have a factive interpretation, but when they take finite embedded clauses with the subordinator *diye* (e.g., the low syntactic interference conditions as in (7b)) they have a non-factive interpretation. To illustrate, compare (10a) to (10b) where both sentences' matrix verb is *bil-* (to know). In (10a) the embedded clause is nominalized as in the high syntactic interference conditions and has a factive reading while in (10b) the embedded clause is finite as in the low syntactic interference conditions and has a non-factive reading.

(10) a. Tunç-Ø [Hillary-nin kazan-dığ-ın-ı]
Tunç-NOM Hillary-GEN win-VN-3SG.POSS-ACC
bil-iyor-Ø.
know-PROG-3SG
'Tunç knows that Hillary won.'

[15] See Özyıldız (2017, p. 401) for a non-exhaustive list of factive alternating verbs in Turkish.

b. Tunç-Ø [Hillary-Ø kazan-dı diye] bil-iyor-Ø.
Tunç-NOM Hillary-NOM win-PF-3SG SUB know-PROG-1SG
'Tunç believes that Hillary won.'

(Özyıldız, 2017, p. 397)

In the experimental stimuli in Experiment 1, the matrix verbs of the seventeen out of twenty-four[16] experimental sentences were such attitude verbs that can have factive and non-factive interpretations depending on the syntactic form of their embedded clauses. The lower ratings and the increased difficulty in detecting the missing VP2 in the low syntactic interference conditions compared to the high syntactic interference conditions could therefore be due to the differences in processing factive and non-factive statements. It was shown in a previous study that it was more difficult to draw inferences from non-factive verbs than factive verbs (Nazlidou et al., 2018). Thus, it is likely that inference generation in non-factive interpretation put extra processing load in the low interference condition, resulting in their lower ratings. The materials in Experiment 3 did not include any matrix verbs that would have factive/non-factive alternation in their interpretation to control for this potential confound.

The results of Experiment 1 also showed evidence for a lack of missing-VP2 illusion in Turkish center-embeddings as the ratings were overall higher for the grammatical sentences than their ungrammatical counterparts. But Experiment 1 also showed that there was a missing-VP2 illusion in the sentences with low syntactic interference (cf. Table 2, equal ratings for the grammatical and ungrammatical sentences). This was also not predicted. The similarity-based interference account predicted the missing VP2 illusion to be prominent in high syntactic interference

[16] The remaining seven verbs were verbs of emotion that can take finite noun clauses or non-finite noun clauses with the subordinator *diye* such as *sevin-* (to get happy) or *üzül-* (to get upset).

conditions. Given that the low syntactic interference conditions were rated to be more difficult (presumably due to inference generation associated with non-factive interpretations for some of the verbs used in the experimental stimuli), it is likely that the missing-VP2 illusion appeared in the harder-to-process (i.e., low syntactic interference) condition. Thus, this result suggests that missing-VP2 illusion may indeed be cross-linguistic as predicted by the resource-based account (Gibson & Thomas, 1999) and may as well be modulated by case interference effects, but only if case interference has been obscured by factive/non-factive alternation verbs in the present experiment. To test this possibility, a follow-up acceptability judgment task with sentential stimuli excluding factive/non-factive alternation verbs is under way.

To sum up, the results of Experiment 1 failed to confirm the predictions of the interference-based account for a facilitative role of decreased syntactic interference on processing Turkish embeddings as well as its predictions for missing-VP2 illusion in Turkish (Lewis, 1996, 19998, 2000; Lewis & Vasishth, 2005; Lewis et al., 2006). There are two possibilities for the unpredicted results for syntactic interference: the task being off-line and the experimental stimuli including factive alternating verbs. More conclusive remarks can be made for these two possibilities with data from Experiment 3, which employed eye-tracking methodology and excluded factive alternanating verbs. Note that there is also a follow-up acceptability judgment task that is currently being designed which will specifically test missing-VP2 illusion in sentences with high/ low syntactic interference excluding factive alternating verbs.

3.3 Experiment 2: Acceptability judgment task testing prosodic phrase lengths effects and missing-VP2 illusion

Experiment 2 investigated whether or not the perceived difficulty of Turkish center-embeddings could be modulated by prosodic phrasing that is induced by phrase lengths, whether or not missing-VP2 illusion existed in Turkish center-embeddings, and whether or not prosodic phrasing modulated the existence of missing-VP2 illusion. Recall from Chapter 2 that Fodor (2013) argues that processing center-embeddings can be facilitated if the construction is phrased as NP1 || RC1 || VP1, and this phrasing can be induced by optimal and balanced lengths of the contributing phrases. This prediction has been confirmed for English center-embeddings (Nickels & Fodor, 2011; Fodor et al., 2017; Fodor et al., 2019), but, to my knowledge, it has not been tested in another language. It has been reported for other constructions, though, that optimal phrase lengths influence sentence processing routines cross-linguistically, including those in Turkish (e.g., Carlson, Clifton, & Frazier, 2001; Clifton, Carlson, & Frazier 2006 for English; Dinçtopal-Deniz, 2014; Deniz & Fodor, 2017; 2019 for Turkish; Lovric, 2003 for Croatian; Pynte, 2006 for French; Sandalo & Truckenbrodt for Brazilian Portuguese; Stoyneshka, Fodor, & Fernandez, 2010 for Bulgarian; Webman-Shafran & Fodor, 2015 for Hebrew). This experiment investigates if the prosodic phrasing of constituents affects processing center-embedded sentences in Turkish and tests the cross-linguistic generalizability of Fodor's (2013) account. Experiment 2 also investigates the presence of missing-VP2 illusion in Turkish center-embedded sentences, and whether or not prosodic phrasing of their constituents influences the illusion. In the phrase lengths account, missing-VP2 illusion is expected to occur in the sentences that are discouraged to be optimally phrased. In non-optimally phrased center-embedded sentences building the

correct syntactic tree is more difficult, putting extra processing difficulty on the parser and making it more vulnerable to the illusion. This prediction was confirmed for English center-embeddings (Fodor et al., 2017). Experiment 2 examines it in Turkish.

Similar to Experiment 1, Experiment 2 was an end-of-sentence acceptability judgment task.

3.3.1 Participants

Thirty-eight native speakers of Turkish (number of females = 21) participated in Experiment 2. The participants' age ranged between 18 and 34 (M = 24.55, SD = 3.70). All of the participants were native speakers of Turkish. All participation in the study was voluntary and informed consent was obtained before data collection (see Appendix A for Ethics Committee Approval). Before the experiment, the participants were instructed to fill out an on-line background questionnaire which elicited information on demographics and language history (see Appendix B). The participants were naïve to the purpose of the study.

3.3.2 Materials

Experiment 2 had four conditions, manipulating Grammaticality (i.e., missing-verb, grammatical: Gra and ungrammatical: Ungra) and Phrase Lengths (phrase lengths encouraging optimal phrasing: ENC and phrase lengths discouraging optimal phrasing: DISC) as illustrated in (11a-b). The manipulation for Grammaticality was the same as in Experiment 1: all three VPs were present in the grammatical conditions as in (11a-b), while VP2, crossed out in (11a-b), was missing in the ungrammatical conditions. To manipulate phrase lengths and encourage a relatively

balanced phrasing of the sentence as NP1 || NP6 || VP1, NP1 and VP1 were each lengthened with two additional prosodic words (PWds), resulting in three PWds each as in (11a). (Note that unlike English where optimal phrasing of the construction is NP1 || RC1 || VP1, optimal phrasing is projected to be as NP1 || NP6 || VP1 in Turkish due to structural differences across the two languages; see below for details.) To discourage the optimal phrasing of the sentence as NP1 || NP6 || VP1, NP6 was lengthened with four additional PWds, and NP1 and VP1 were one PWd each as in (11b). Overall sentence length was the same across the Encouraging and Discouraging Phrase Lengths conditions. In (11a-b) colored words show phrase lengths manipulation: green for words added to create encouraging phrase lengths and red for words added to create discouraging phrase lengths. In all the examples in this chapter, including (11), "||" marks prosodic boundaries predicted to be induced implicitly. VP2s that were omitted in the ungrammatical conditions are crossed out in (11a-b), and additional adjectives, in parentheses in (11a-b) replaced the omitted verbs to control for overall sentence length across the grammatical and ungrammatical conditions.

(11) a. ENC, Gra/Ungra

Ø [İşinin ehli marangoz-lar-ın || [nakliyeci-ler-in [kiracı-nın

Pro expert carpenter-PL-GEN mover-PL-GEN tenant-GEN
NP1 *NP6*

gri koltuğ-u yerleştir-diğ-i] oda-ya

gray sofa-ACC place-PART-3SG.POSS room-DAT

taşı-dık-ları/ ~~taşıdıkları~~] (ahşap) dolab-ı || dikkatli şekilde

move-PART-3PL.POSS wooden closet -ACC careful manner
VP1

kur-duk-ları-nı] bil-iyor-um.

set.up-VN-3PL.POSS-ACC know-PROG-1SG

b. DISC, Gra/Ungra

Ø [Marangoz-lar-ın || [nakliyeci-ler-in [kiracı-nın

Pro carpenter-PL-GEN mover-PL-GEN tenant-GEN
NP1 *NP6*

oldukça geniş gri koltuğ-u büyük özen-le

extremely large gray sofa-ACC great care-with

yerleştir-diğ-i] oda-ya taşı-dık-ları/ ~~taşıdıkları~~]

place-PART-3SG.POSS room-DAT move-PART-3PL.POSS

(ahşap) dolab-ı || kur-duk-ları-nı]

wooden closet-ACC set.up-VN-3PL.POSS-ACC
VP1

bil-iyor-um.

know-PROG-1SG

'I know that the expert carpenters carefully set up the wooden closet that the movers moved/ ~~moved~~ to the room where the tenant placed the extremely large gray sofa with great care.'

Recall from Chapter 2 that Fodor (2013) maintains that the processing of English center-embeddings can be eased when the sentence is optimally phrased as NP1 || RC1 || VP1. The prosodic boundaries in the optimal phrasing of NP1 || RC1 || VP1 aligns with the syntactic structure of the sentence. Moreover, Fodor claims that the contributing phrases in the optimal phrasing of NP1 || RC1 || VP1 should be rhythmically acceptable, i.e., they should have optimum and balanced lengths. In this study, the role of prosodic phrasing induced by phrase lengths in processing center-embedded structures is extended to Turkish. That is, this study aims to reveal whether processing Turkish center-embeddings can be facilitated when the structure is optimally phrased, and the prosodic boundaries in the optimal phrasing aligns with the syntactic boundaries of Turkish center-embeddings. But given the structural differences across the two languages, optimal phrasing of the construction in Turkish would be NP1 || NP6 || VP1 because in Turkish the first prosodic boundary is predicted after NP1, as in English, but the second prosodic boundary is predicted after NP6, unlike English. These prosodic boundaries also align with syntactic boundaries. I will explain the second prosodic boundary first.

The second boundary is predicted to be placed between VP1, *kur-duk-ları-nı* (set.up-PART-3PL.POSS-ACC), and the object NP6, *dolab-ı* (closet-ACC). Both NP6 and VP1 form separate syntactic units; NP6 forms a relativized object NP, and VP1 forms a transitive embedded verb that requires an object and a subject. In Turkish, definite objects are marked with the accusative case marker *-(y)I* , but they are usually not case-marked if they are indefinite (Göksel & Kerslake, 2005). According to Özçelik and Nagai's (2011) analysis on the relation between phonological phrasing and syntactic positions of subjects and objects, definite arguments such as accusative-case-marked objects are in a different syntactic

projection than the verb, and they create a separate phonological phrase. In the experimental stimuli of the present study, NP6 is always marked with the accusative case and it is definite; hence, a prosodic boundary following NP6 is expected.

Figure 7 illustrates the syntactic structure of the sentence in (11a). In Figure 7 the syntactic heads of the prosodic phrases are underlined.

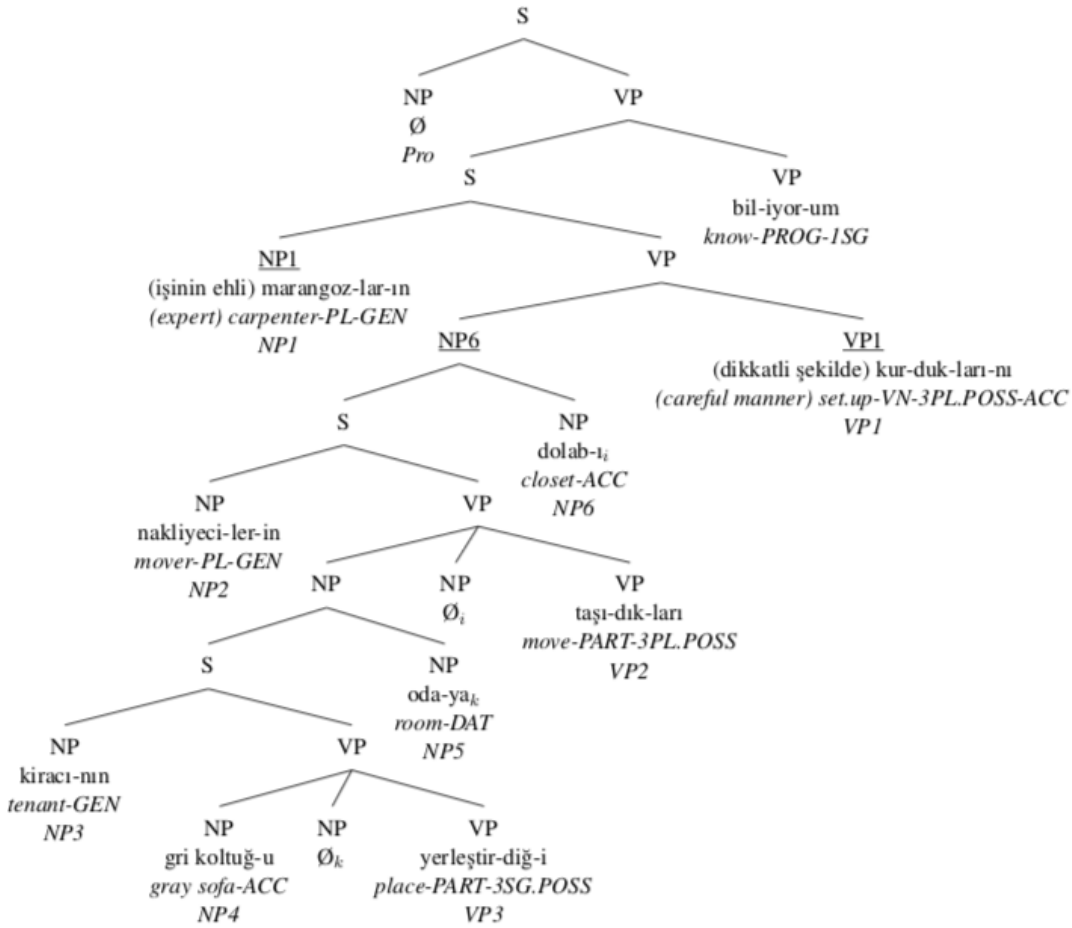


Figure 7. Surface structure of the Turkish center-embedding in (11a). The additional words for the phrase length manipulation are in parentheses, and the syntactic heads of the three prosodic phrases are underlined.

As shown in Figure 7, the prosodic packages of NP6 and VP1 are syntactic sisters. That is, NP6, *dolab-ı* (closet-ACC), is the direct object of VP1, *kur-duk-ları-nı* (set.up-VN-3PL.POSS-ACC). Thus, the prosodic boundary that is placed between NP6 and VP1 aligns with a syntactic boundary.

The first prosodic boundary in (11a-b) is predicted to be placed after the first (embedded) subject NP, *marangoz-lar-ın* (carpenter-PL-GEN), forming a prosodic package for NP1. Although the prosodic package of NP1 forms a coherent syntactic unit on its own, as Figure 7 illustrates, it is not a syntactic sister to the two other packages in the sentence, namely NP6 and VP1. But given the prosodic properties of Turkish, it is legitimate to expect a prosodic boundary after NP1. In Turkish the default topic position is sentence-initial (Erguvanlı, 1984; Göksel & Kerslake, 2005; İşsever, 2003; Kornfilt, 2011). Turkish is an SOV language ,and subjects typically occur at sentence-initial positions. As a result, subjects are default topics unless a different word order is used. It is also possible to topicalize the constituents of embedded clauses by either moving them out of their clause or by placing a prosodic boundary after them when they are in-situ (Erguvanlı, 1984). In Turkish a topic usually has an exaggerated high pitch accent with an optional pause following it (Kamali, 2008; Vallduvi & Engdal, 1996). And such acoustic properties are associated with intonational phrase (IPh) boundaries (Kan, 2009). These observations were experimentally tested and confirmed in Dinçtopal-Deniz (2014). In the experimental sentences in the present study, the first NP is the subject of the first embedded clause (note that the matrix clause has a null subject indicated as *pro* in (9)). Given the previous literature on IPh boundaries associated with embedded subjects, it is reasonable to predict a prosodic break in the experimental sentences after the first (embedded) subject NP, NP1, *marangoz-lar-ın* (carpenter-PL-GEN) in (11a-b).

The prosodic phrasing of NP1 || NP6 || VP1 is optimal for Turkish center-embeddings when NP1 and VP1 are each heavy enough to stand alone, and NP6 is light enough to not need further dividing. That is, the contributing phrases must have

optimal and balanced lengths in order to encourage the optimal phrasing of the sentence as NP1 || NP6 || VP1. In Turkish every lexical word is realized as a PWd (Inkelas & Orgun, 2003). The Turkish center-embeddings in (11a-b) have fifteen PWds. The sentence in the Encouraging Phrase Lengths condition as in (11a) is predicted to be grouped as 3+8+4 PWds when phrased as NP1 || NP6 || VP1. Dinctopal-Deniz's (2014) analysis of Nash's (1973) data shows that Turkish readers pause at every 4.2 words on average, with a range from 2.9 to 7.8 words. The 3-PWd phrase for NP1 and the 4-PWd phrase for VP1 in the experimental sentences in (11a), thus, fall within the range of optimal phrase lengths. The 8-PWd phrase for NP6 is borderline but can be considered to fall within the range of acceptable phrase lengths. Hence, the phrasing of 3+8+4 PWds in the sentence in (11a) is relatively balanced and optimal, and it encourages the optimal phrasing of the sentence as NP1 || NP6 || VP1. The sentence in the Discouraging Phrase Lengths condition as in (11b), on the other hand, is grouped as 1+12+2 PWds when phrased as NP1 || NP6 || VP1. Since the contributing phrases in (11b) do not have optimal and balanced lengths, given Dinctopal-Deniz's (2014) analysis of Nash's data, they discourage the optimal phrasing of the sentence as NP1 || NP6 || VP1. That is, the sentence in (11b) is not expected to be phrased as NP1 || NP6 || VP1 due to rhythmically unacceptable contributing phrases.

Note that the relatively long prosodic phrase of NP6, which contains NP2, NP3, NP4, VP3, NP5, VP2 and NP6, can be further divided into smaller chunks to form more optimal and balanced phrase lengths, but I do not predict that the readers would do so as it would distort the alignment between the prosodic breaks and syntactic boundaries. Given the literature on IPh boundaries associated with embedded subjects (see above for details), one might predict prosodic breaks after

the second and third (embedded) subject NPs, namely NP2, *nakliyeci-ler-in* (mover-PL-GEN), and NP3, *kiracı-nın* (tenant-GEN), respectively, since they are also the subjects of their clauses that can be topicalized. Having prosodic boundaries after NP2 and NP3 would result in the phrasing of the sentence as NP1 || NP2 || NP3 || NP6 || VP1. Although this phrasing can be rhythmically achieved by lengthening the subjects NP2 and NP3, it is unlikely to ease the processing of the sentence because the resulting prosodic phrases would not be syntactic sisters to one another. These intuitions were tested through a norming study which tested if the prosodic phrasing of NP1 || NP6 || VP1 was the optimal phrasing for Turkish center-embeddings as predicted.

A norming study was conducted to examine Turkish speakers' preferences for the prosodic phrasing of Turkish center-embeddings. In the norming study six linguistically-informed judges participated, but they were naïve to the purpose of the study. They were presented with twenty-four Turkish center-embeddings, half of which had phrase lengths encouraging the optimal phrasing as in (11a) and the other half had phrase lengths discouraging the optimal phrasing as in (11b). They were asked to insert two-three commas in the sentences. The commas were used as an indication of prosodic boundaries given the ERP results showing that commas in silent reading are treated similar to overt prosodic boundaries in listening (Steinhauer et al., 1998, 1999) (see Chapter 2 for further details). There were 144 sentences in total.

The norming data showed that all the judges placed a comma after NP1, which was the first prosodic boundary in the projected optimal phrasing of NP1 || NP6 || VP1, in all the sentences that they were presented with (100%). The number of commas after NP6, which was the second prosodic boundary in the optimal

phrasing, was 48 (33%). Two judges also placed a comma after NP2, in a total of 44 sentences (30.5%). There was no reliable difference between the sentences encouraging or discouraging the optimal phrasing. These findings mostly confirm the optimal phrasing of Turkish center-embeddings as NP1 || NP6 || VP1, but the third comma, after NP2, was not predicted. It is possible that it could be added given the instructions asking for two or three commas. Note that the third comma was placed by only two judges, so it is likely that there is individual difference in phrasing preferences (see Fodor et al., 2019 for similar findings on English). But a further study which investigates the produced prosodic contour for Turkish center-embeddings would provide more conclusive remarks.

As in Experiment 1, there were twenty-four experimental sentence sets, each of which consisted of four conditions as illustrated in (11) above (see Appendix E for the full list of experimental stimuli). The experimental sentences were distributed across four lists controlling for grammaticality (grammatical vs. ungrammatical) and phrase lengths (encouraging vs. discouraging). The experimental sentences were interspersed in a list of thirty-six filler sentences (see Appendix F for the full list of filler items). The length of the fillers was comparable to those of experimental sentences. As in Experiment 1, to successfully disguise the experimental sentences, twelve of the fillers were structurally similar to the experimental sentences, but they included at most two levels of embeddings (cf. three levels of embedding in the experimental sentences); hence, they were less complex than the experimental items. Following Christiansen and MacDonald (2009), Dokudan et al. (2017), Frank and Ernst (2018) and Huang and Phillips (2020), twelve of the filler items were ungrammatical to disguise the ungrammatical missing-VP2 sentences. The ungrammaticality in these sentences was due to active-passive misalignment, number

disagreement or wrong case marking. The remaining twelve fillers included sentences which were structurally less complex. They were included to increase the participants' confidence in their ratings. In each list the proportion of ungrammatical sentences was 40%. All the sentences in each list (including fillers) were followed by a statement whose truth value would be judged by the participants as "yes" or "no" response. 50% of the responses required a "true" response and the other 50% required a "false" response. Following Frank et al. (2016) and Vasishth et al. (2010), comprehension statements for the experimental items were designed to include information about four different subject-verb relations, e.g., NP1-VP1, NP1-VP3, NP3-VP1 or NP3-VP3, as shown in (9) (see Appendix E for the full list of comprehension questions for each experimental stimuli). As in Frank et al.'s (2016) study, none of the comprehension questions were about the second verb (VP2) to prevent attention to the missing-VP2 in the ungrammatical conditions. Comprehension statements were distributed across four lists, and each sentence was followed by one of these questions.

(12) a. *NP1-VP1:* Marangozlar dolabı kurdu.
'The carpenters set up the closet.'

b. *NP1- VP3:* Marangozlar koltuğu yerleştirdi.
'The carpenters placed the sofa.'

c. *NP3-VP1:* Kiracı dolabı kurdu.
'The tenant set up the closet.'

d. *NP3-VP3:* Kiracı koltuğu yerleştirdi.
'The tenant placed the sofa.'

3.3.3 Procedure

The procedure was the same as in Experiment 1.

3.3.4 Predictions

Experiment 2 tested three questions: (i) do prosodic phrase lengths influence the processing of Turkish center-embeddings, (ii) is there missing-VP2 illusion in Turkish center-embeddings, and (iii) do prosodic phrase lengths modulate missing-VP2 illusion? Predictions for these questions are outlined below.

Recall from Chapter 2 that 2-CE-RCs with a missing second verb are observed to be regarded as equally acceptable as or more acceptable than their grammatical versions with all three verbs present. The results of Experiment 1 showed no illusion in Turkish, supporting the experience-based accounts for it (Frank & Ernst, 2018; Frank et al., 2016; Vasishth et al., 2010). But the sentential material in Experiment 1 induced similarity-based interference, which may have obscured the illusion. Experiment 2 tests the same question in relation to prosodic phrase lengths in sentential items that have no syntactic or phonological case-related similarity in the subject/object NPs.

The prosodic phrase length account of center-embedding difficulty maintains that the processing of 2-CE-RCs can be facilitated if the construction is phrased optimally (Fodor, 2013). The optimal phrasing for Turkish 2-CE-RCs can be NP1 || NP6 || VP1 as it would align with the syntactic structure of the sentence. The phrasing of the construction as NP1 || NP6 || VP1 can be induced by manipulating the lengths of the contributing phrases such that they have optimal and balanced phrase lengths. If Fodor's predictions hold true for Turkish, the sentences which encourage the phrasing of the sentence as NP1 || NP6 || VP1 with optimal and relatively more

balanced phrase lengths as in (11a) will be rated higher for their acceptability than sentences that discourage the phrasing of the sentence as NP1 || NP6 || VP1 with non-optimal and unbalanced phrase lengths as in (11b).

Fodor (2013) also predicts that when a center-embedded sentence is easier to process, i.e., as in the conditions encouraging optimal phrase lengths as in (11a), it will be easier for language users to detect the missing VP2. This would result in higher acceptability ratings for the ungrammatical conditions with discouraging phrase lengths as in (11b) compared to those with encouraging phrase lengths as in (11a).

3.3.5 Data Analysis

The procedure for data analysis was the same as that in Experiment 1.

3.3.6 Results

The data inclusion criterion for the participants was 60%. The average comprehension accuracy of two participants on experimental and filler items combined was below 60%; thus, they were excluded from the analyses. The overall comprehension accuracy of the remaining thirty-six participants was 73% on average, confirming that they were actively reading the stimuli for comprehension.

The main analyses were run on the acceptability ratings. Grammaticality and Phrase Lengths were included as fixed effects (the predictor variables); subjects and items were included as random effects. Grammaticality had two levels; Grammatical as in (11a-b) and Ungrammatical as in (11a-b); and Phrase Lengths had two levels; Encouraging Phrase Lengths as in (11a) and Discouraging Phrase Lengths as in (11b). As in Experiment 1, Following Frank et al. (2019), the predictor variables

were sum-coded: the ungrammatical conditions were coded as -0.5 and the grammatical conditions were coded as 0.5; the discouraging phrase lengths conditions were coded as -0.5 and the encouraging phrase lengths conditions were coded as 0.5. Thus, a positive sign indicates higher ratings for the grammatical and low interference conditions, whereas a negative sign indicates lower ratings for the ungrammatical and high interference conditions. In all the following analyses, the models included random slopes for subjects and items by the predictor variables.

Table 4 shows the mean and standard error values for the acceptability ratings in Experiment 2.

Table 4. Mean and Standard Errors (in Parentheses) for Acceptability Ratings in Experiment 2

	Encouraging Phrase Lengths	Discouraging Phrase Lengths
Grammatical	2.87 *(.09)*	2.69 *(.09)*
Ungrammatical	2.63 *(.08)*	2.54 *(.08)*

As in the analyses of Experiment 1, the relationship between the ratings and Trial number was examined before the main analyses. This analysis showed that Trial number was a marginally significant predictor (β = .007, *SE* = .004, *z* = 1.91, *p* = .06) and therefore, it was included as a predictor variable in the main analyses.

Analyses with Grammaticality as a predictor showed that the participants rated the sentences in the Grammatical conditions marginally higher than those in the Ungrammatical conditions (β = .36, *SE* = .19, *z* = 1.88, *p* = .06). Similarly, analyses with Phrase lengths as a predictor showed that the participants rated the sentences in the Encouraging Phrase Lengths conditions marginally better than those in the Discouraging Phrase Lengths conditions (β = .25, *SE* = .14, *z* = 1.76, *p* = .07).

The complex model with two predictors (Grammaticality and Phrase Lengths) explained the data better than the simple model with Phrase Lengths as a

predictor variable ($\chi 2$ (7) = 23.76, $p < .01$). In order to understand how the Grammaticality and Phrase Lengths predictors may have contributed to the data in the complex model with two predictors, the data were split, and the effects of (un)grammaticality was examined in each Encouraging and Discouraging Phrase Lengths conditions individually. In the Encouraging Phrase Lengths conditions, the sentences in the Grammatical condition were rated significantly higher than those in the Ungrammatical conditions ($\beta = .48$, $SE = .25$, $z = 1.92$, $p = .05$). Yet, in the Discouraging Phrase Lengths conditions, there was no reliable difference between the ratings of the sentences in the Grammatical and Ungrammatical conditions ($\beta = .21$, $SE = .20$, $z = 1.03$, $p = .30$).

The results show the pattern in Table 5 below.

Table 5. Acceptability Rating Pattern in Experiment 2, ">" indicates higher ratings at the alpha level of .05, and "=" indicates no significant difference in ratings

	Encouraging Phrase Lengths	Discouraging Phrase Lengths
Grammaticality	Grammatical > Ungrammatical	Grammatical = Ungrammatical

Analyses for the filler items showed that the grammatical fillers ($M = 4.50$, $SE = .04$) received significantly higher ratings than the ungrammatical fillers ($M = 2.59$, $SE = .07$) ($\beta = 3.86$, $SE = .51$, $z = 7.57$, $p < .001$).

As in Experiment 1, although comprehension questions were designed to check for reading comprehension rather than to provide evidence for theoretical issues, following Vasishth et al. (2010), for completeness the participants' accuracy in the comprehension questions were analyzed. Table 6 shows average comprehension accuracy in each condition.

Table 6. Average Comprehension Accuracy in Experiment 2

	Encouraging Phrase Lengths	Discouraging Phrase Lengths
Grammatical	85%	77%
Ungrammatical	69%	63%

Analyses with Phrase Lengths demonstrated that the participants' accuracy was higher in the Encouraging Phrase Lengths conditions than in the Discouraging Phrase Lengths conditions (β = .42, *SE* = .21, *z* = 1.96, $p < .05$). Their accuracy was also higher in the Grammatical conditions than that in the Ungrammatical conditions (β = .88, *SE* = .19, *z* = 4.62, $p < .001$).

A complex model with two predictors (Grammaticality and Phrase Lengths) explained the data better than the simple model with Phrase Lengths ($\chi 2(1) = 28.31$, $p < .001$). In order to understand how the Grammaticality and Phrase Lengths predictors may have contributed to the data in the complex model with two predictors, the data were split, and the effects of (un)grammaticality was examined in each Encouraging and Discouraging Phrase Lengths conditions individually. The results showed higher accuracy in the Grammatical conditions than in the Ungrammatical conditions in both Encouraging (β = 1.15, *SE* = .39, *z* = 2.97, $p < .01$) and Discouraging Phrase Lengths conditions (β = .65, *SE* = .27, *z* = 2.38, $p < .05$).

3.3.7 Discussion

Experiment 2 investigated if there was a missing-VP2 illusion in Turkish center-embeddings, and if an optimum phrasing of NP1 || NP6 || VP1 that is induced by optimal and relatively balanced phrase lengths influenced the processing of Turkish center-embeddings and/or modulated missing-VP2 illusion. There were three main findings: (i) sentences for which optimal phrasing was encouraged received higher

ratings than those for which optimal phrasing was discouraged; (ii) the grammatical center-embeddings overall received higher acceptability ratings than their ungrammatical versions with a missing VP2; (iii) there was missing-VP2 illusion in sentences with phrase lengths discouraging optimal phrasing of the sentence as NP1 || NP6 || VP1, but not in those with phrase lengths encouraging optimal phrasing of the sentence as NP1 || NP6 || VP1.

The result that the participants rated the encouraging phrase lengths conditions higher than discouraging phrase lengths conditions confirms Fodor's (2013) predictions for one potential source of difficulty of doubly-center-embedded sentences, namely non-optimal prosodic phrasing. In conditions where the phrase lengths of constituents encouraged an optimal and relatively balanced construction whose prosodic boundaries aligned with its syntactic boundaries, the sentences were rated to be more acceptable (and presumably less difficult). This prediction was previously supported in English center-embeddings (Fodor & Nickels, 2011; Fodor et al., 2017). The findings of this experiment provide cross-linguistic evidence for and extends Fodor's model to Turkish, a language that is typologically different from English.

Similar to the findings of Experiment 1, the results of Experiment 2 showed overall higher ratings for the grammatical sentences than the ungrammatical sentences with a missing-VP2 in general, suggesting that the illusion does not exist in Turkish center-embeddings. However, the result that there was missing-VP2 illusion in the discouraging conditions (cf. Table 5, equal ratings for the grammatical and ungrammatical sentences) as opposed to encouraging conditions suggest that the illusion is cross-linguistic and is modulated by optimum and balanced phrase lengths. This also confirms Fodor's (2013) predictions in that it was easier for the participants

to detect the absence of VP2 in sentences that encouraged optimal phrasing of the structure than in sentences that discouraged optimal phrasing of the structure. This observation suggests that missing-VP2 illusion may indeed be cross-linguistic, supporting the predictions of the resource-based account (Gibson & Thomas, 1999), and it may be modulated by prosodic phrasing. Moreover, the modulation of missing-VP2 illusion is in line with the data from Experiment 1, which showed that missing-VP2 illusion was more likely to occur when the sentence was rated less acceptable and presumably more difficult. Further research in other head-final languages examining missing VP2 illusion with phrase lengths and case interference would be necessary to make more conclusive remarks on the interaction between missing-VP2 illusion and other factors.

3.4 Experiment 3: Eye-tracking experiment testing case interference and prosodic phrase lengths effects

Experiments 1 and 2 independently examined the effects of syntactic interference and prosodic phrase lengths in processing Turkish center-embeddings. Both experiments used off-line measures. Experiment 3 investigated these two factors in a single design, using eye-tracking methodology.

The results of Experiment 1 showed syntactic interference effects, but in the unpredicted direction. Several studies testing the predictions of the interference-based account in on-line measures such as self-paced reading or eye-tracking showed interference effects, though (Arnett & Wagers, 2017; Gordon, Hendrick, & Johnson., 2001; 2004; Uehara, 2003; van Dyke, 2007; van Dyke & Lewis, 2003; van Dyke & McElree, 2006; Vasishth, 2003; among others), and one potential cause of unpredicted interference effect was considered to be the task being off-line in

Experiment 1. Alternatively, the unpredicted pattern of results in Experiment 1 was attributed to the use of factive alternant verbs. Thus, Experiment 3 tests the predictions of similarity-based interference as in Experiment 1, but with better controlled stimuli and using an on-line measure. The data from an on-line experiment could also inform on when interference effects influence parsing, if there is any. Recall from Chapter 2 that similarity-based interference may take effect either during encoding or retrieving the target item, and retrieval interference effects might be caused by distractors that precede or follow the target item (proactive interference and retroactive interference, respectively). End-of-sentence judgment tasks do not allow to differentiate which type of interference influences judgments. Eye-tracking data, on the other hand, can provide information for different regions in the sentence, which can differentiate between different types of interference effects.

Experiment 2 showed effects of prosodic phrase lengths in processing center-embedded sentences, but the task was also off-line there and did not inform on when prosodic phrase lengths influence the processing of the sentence. It has been reported in a study that investigated the effects of phrase lengths on the perceived cue-strength of prosodic breaks in Turkish that effects of phrase lengths may be delayed compared to other factors such as syntactic cues to sentence comprehension (Deniz & Fodor, 2017; 2019). This finding was in line with the predictions of Fodor (2002) who suggested that prosodic effects may sometimes fall behind syntactic parsing. But it has also been reported in several ERP studies that the brain responses to (implicit) prosodic boundaries were immediate (e.g., Steinhauer & Friederici, 2001). In the present study, the projection of prosodic boundaries is not in competition with another cue such as syntax; so, it is also likely that prosodic breaks can be projected immediately. The investigation of phrase lengths in an on-line measure would,

therefore, inform on the time-course of phrase lengths effects. Also, if both interference and phrase length effects modulate the processing difficulty of Turkish center-embeddings, data from on-line measures would reveal whether one source of information precedes the other or both factors influence parsing around the same time. The employment of eye-tracking methodology would enable us to answer these questions since data from eye-tracking methodology give us information about both early and later stages of processing (Rayner et al., 1989) and for different regions in a sentence.

Experiment 3 examined the effects of these two factors in real-time processing of center-embedded sentences in Turkish. Missing-VP2 illusion was not tested in Experiment 3.

3.4.1 Participants

Forty-four native speakers of Turkish (number of females = 29) participated in Experiment 3. The participants' age ranged between 19 and 31 (M = 20.67, SD = 2.07). All of the participants were native speakers of Turkish. All participation in the study was voluntary and informed consent was obtained before data collection (see Appendix A for Ethics Committee Approval). Before the experiment, the participants were asked to fill out a background questionnaire which elicited information on demographics and language history (see Appendix B). All the participants had normal or corrected-to-normal (with glasses or contact-lenses) vision. The participants were given course credit for their participation in the experiment. The participants were naïve to the purpose of the experiment.

3.4.2 Materials

Experiment 3 had six conditions, manipulating Case Interference (high syntactic - high phonological interference: HighSyn-HighPhono, low syntactic - high phonological interference: LowSyn-HighPhono and low syntactic - low phonological interference: LowSyn-LowPhono) and Phrase Lengths (phrase lengths encouraging optimal prosodic phrasing: ENC and phrase lengths discouraging optimal prosodic phrasing: DISC), as illustrated in (13). To manipulate Case Interference, all three subject NPs, NP1, NP2 and NP3, were marked for genitive case in the high syntactic - high phonological interference conditions as in (13a, d); the subjects NP2 and NP3 and the first object, NP4, were marked for genitive case in the low syntactic - high phonological interference conditions as in (13b, e); and in the low syntactic - low phonological case interference condition only the second and the third subjects, NP2 and NP3, were marked for genitive case as in (13c, f). To manipulate Phrase Lengths, NP1 and VP1 were each lengthened with two additional PWds, encouraging a relatively balanced phrasing of the sentence as NP1 || NP6 || VP1 with a grouping of 3+8+4 PWds as in (13a-c); or RC1 was lengthened with four additional PWds, and NP1 and VP1 were one PWd each, discouraging the optimal phrasing of the sentence as NP1 || NP6 || VP1, with a grouping of 1+12+2 PWds as in (13d-f). Overall sentence length was the same across encouraging and discouraging phrase lengths conditions. There was no missing VP in Experiment 3. In (13) case marking is in bold face, and colored words show phrase lengths manipulation: green for words added to create encouraging phrase lengths and red for words added to create discouraging phrase lengths.

(13) a. ENC, HighSyn-HighPhono

Ø [**İşinin ehli** marangoz-lar-**ın** || [nakliyeci-ler-**in**

Pro expert carpenter-PL-GEN mover-PL-GEN
NP1-GEN *NP2-GEN*

[kiracı-**nın** gri koltuğ-u yerleştir-diğ-i]

tenant-GEN gray sofa-ACC place-PART-3SG.POSS
NP3-GEN *NP4-ACC* *VP3*

odaya taşı-dık-ları] dolab-ı || **dikkatli**

room-DAT move-PART-3PL.POSS closet -ACC careful
VP2

şekilde kur-duk-ları-nı] san-dı-m.

manner set.up-VN-3PL.POSS-ACC think-PF-1SG
VP1

b. ENC, LowSyn-HighPhono

Ø [**İşinin ehli** marangoz-lar-**Ø** || [nakliyeci-ler-**in**

Pro expert carpenter-PL-NOM mover-PL-GEN
NP1-NOM *NP2-GEN*

[kiracı-**nın** koltuğ-**un** minder-ler-i-ni

tenant-GEN sofa-GEN cushion-PL-POSS-ACC
NP3-GEN *NP4*-GEN

yerleştir-diğ-i] odaya taşı-dık-ları]

place-PART-3SG.POSS room-DAT move-PART-3PL.POSS
VP3 *VP2*

dolab-ı || **dikkatli** **şekilde** kur-du-lar] san-dı-m.

closet -ACC careful manner set.up-PF-3PL think-PF-1SG
VP1

c. ENC, LowSyn-LowPhono

Ø [**İşinin ehli** marangoz-lar-**Ø** || [nakliyeci-ler-**in**

Pro expert carpenter-PL-NOM *NP1-NOM* mover-PL-GEN *NP2-GEN*

[kiracı-**nın** gri koltuğ-**u** yerleştir-diğ-i]

tenant-GEN *NP3-GEN* gray sofa-ACC *NP4-ACC* place-PART-3SG.POSS *VP3*

odaya taşı-dık-ları] dolabı || **dikkatli**

room-DAT move-PART-3PL.POSS *VP2* closet-ACC careful

şekilde kur-du-lar] san-dı-m.

manner set.up-PF-3PL *VP1* think-PF-1SG

d. DISC, HighSyn-HighPhono

Ø [Marangoz-lar-**ın** || [nakliyeci-ler-**in** [kiracı-**nın**

Pro carpenter-PL-GEN *NP1-GEN* mover-PL-GEN *NP2-GEN* tenant-GEN *NP3-GEN*

oldukça geniş gri koltuğ-u **büyük özen-le**

extremely large gray sofa-ACC *NP4-ACC* great care-with

yerleştir-diğ-i] odaya taşı-dık-ları]

place-PART-3SG.POSS *VP3* room-DAT move-PART-3PL.POSS *VP2*

dolab-ı || kur-duk-ları-nı] san-dı-m.

closet-ACC set.up-VN-3PL.POSS-ACC *VP1* think-PF-1SG

e. DISC, LowSyn-HighPhono

Ø [Marangoz-lar-**Ø** || [nakliyeci-ler-**in** [kiracı-**nın**

Pro carpenter-PL-NOM mover-PL-GEN tenant-GEN
NP1-NOM *NP2-GEN* *NP3-GEN*

koltuğ-**un** **oldukça** **geniş** minder-ler-i-ni

sofa-GEN extremely large cushion-PL-3SG.POSS-ACC
NP4-GEN

büyük **özen-le** yerleştir-diğ-i] odaya

great care-with place-PART-3SG.POSS room-DAT
VP3

taşı-dık-ları] dolab-ı || kur-du-lar] san-dı-m.

move-PART-3PL.POSS closet-ACC set.up-PF-3PL think-PF-1SG
VP2 *VP1*

f. DISC, LowSyn-LowPhono

Ø [Marangoz-lar-**Ø** || [nakliyeci-ler-**in** [kiracı-**nın**

Pro carpenter-PL-NOM mover-PL-GEN tenant-GEN
NP1-NOM *NP2-GEN* *NP3-GEN*

oldukça **geniş** gri koltuğ-u **büyük** **özen-le**

extremely large gray sofa-ACC great care-with
NP4-ACC

yerleştir-diğ-i] odaya taşı-dık-ları]

place-PART-3SG.POSS room-DAT move-PART-3PL.POSS
VP3 *VP2*

dolab-ı || kur-du-lar] san-dı-m.

closet-ACC build-PF-3PL think-PF-1SG
VP1

'I know that the expert carpenters carefully set up the closet that the movers moved to the room where the tenant placed the extremely large gray sofa/sofa's cushions with great care.'

In Experiment 1 similarity-based interference was manipulated for only syntactic interference while phonological interference was held constant across the two conditions there. In Experiment 3, phonological interference was also manipulated by bringing the number of levels to three for the Case Interference variable. Thus, in addition to the high syntactic – high phonological interference conditions as in (13a, d) and the low syntactic – high phonological interference conditions as in (13b, e), which were identical to those in Experiment 1, a third condition of low phonological interference as in (13c, f) was added. In this condition, the first object NP, *koltuğ-u* (sofa-ACC), was marked with the accusative case marker *–(n)I*, instead of the genitive case marker *–(n)In*. This decreased the number of both syntactically and phonologically similar NPs to two. This additional condition tested whether or not decreasing both syntactic and phonological interference among the NPs eased the processing difficulty of Turkish center-embeddings.

Recall from Section 3.2.2 that case marking manipulation in Experiment 1 was created by using finite noun clauses embedded in a matrix clause in the low syntactic interference conditions and non-finite noun clauses embedded in a matrix clause in the high syntactic interference conditions. This required the use of the subordinator *diye* in the low syntactic interference conditions which led to a non-factive interpretation of the matrix verbs in the low syntactic interference conditions and factive interpretation of the matrix verbs in the high syntactic interference conditions. But as was discussed in Experiment 1, the non-factive inference may have required additional, discourse-related resources as the readers would need to make inferences in the low syntactic interference conditions. There was no inference-generation required in the high syntactic interference conditions. This could have

made the low syntactic interference conditions more difficult to process and to be rated less acceptable than the high syntactic interference conditions. The experimental sentences in Experiment 3, therefore, did not include the subordinator *diye,* and matrix verbs were revised to cognition verbs such as *san-* (to think) and *zannet-* (to consider). Cognition verbs can take either finite or non-finite complements without the use of a subordinator (Göksel & Kerslake, 2005) and as a result, they would not have factive/non-factive interpretation (see Dinçtopal-Deniz, 2014 for a similar strategy).

A content-neutral two-word follow-up sentence such as "Yakında taşınacaklarmış" *(I heard that they would move in soon)* was added after each experimental sentence. The follow-up sentence was added to prevent the spill-over region to be the last word of the trial, the RTs on which may be confounded by sentence wrap-up effects (Just & Carpenter, 1980; King & Just, 1991).

There were twenty-four experimental sentence sets, each of which consisted of six conditions as illustrated in (13) above (see Appendix G for the full list of experimental stimuli). The experimental sentences were distributed across six lists counterbalancing for Case Interference (high syntactic – high phonological, low syntactic – high phonological or low syntactic – low phonological) and Phrase Lengths (encouraging vs. discouraging optimal phrasing). The experimental sentences in each list were intermingled with seventy-two filler items. The length of the twenty-four filler items was comparable to that of the experimental sentences. Among the twenty-four sentences that were of equal length to the experimental items, twelve of them were structurally similar to the experimental sentences, but they included at most two levels of embeddings (cf. three levels of embedding in the experimental sentences). They were included to disguise the experimental sentences.

The remaining twelve filler items in this group included sentences which were structurally less complex. They were included to disguise the experimental stimuli (see Appendix H for the list of these filler items). The remaining forty-eight filler sentences were unrelated to the experimental conditions. All the sentences in each list (including fillers) were followed by a comprehension question which would be answered by the participants as "yes" or "no". 50% of the responses required a "yes" response, and the other 50% required a "no" response (see Appendix G for the full list of comprehension questions for each experimental stimuli). As illustrated in (14), the comprehension questions in Experiment 3 were passivized "yes-no" questions asking about either the first or the second object NP, namely NP4 or NP5 in the sentence. These comprehension questions were chosen to prevent participants from a shallow processing strategy in which they might be only matching the subjects with their verbs rather than attending to comprehend the full sentence. Comprehension questions were distributed across two lists, repeating for the following six lists.

(14) a. *The first object NP:* Koltuk yerleştirildi mi?
'Was the sofa placed?'

b. *The second object NP:* Oda boyandı mı?
'Was the room painted?'

3.4.3 Predictions

Experiment 3 tested three questions: (i) do(es) syntactic and/or phonological interference influence the real-time processing of Turkish center-embeddings; (ii) do prosodic phrase lengths take effect immediately as Turkish readers process Turkish center-embeddings; (iii) does one factor (interference or phrase lengths) take precedence over the other in real-time processing decisions or do they both inform

parsing decisions; and (iv) if the two factors co-exist, does one of the factors (similarity-based cues or phrase lengths) take effect sooner than the other? The predictions for these questions are outlined below.

As discussed in detail in Chapter 2 (and also in Experiment 1), the interference-based account for center-embedding difficulty claims that decreasing the similarity of the subject NPs increases the processability of the structure as it eases the retrieval of the correct subject NPs for VPs (Lewis & Vasishth, 2005; Lewis et al., 2006; among others). Experiment 3 examines both syntactic and phonological similarity, each of which was reported to negatively affect processing of center-embedded structures (Nakayama et al., 2005; Uehara, 2003; Uehara & Bradley, 1996 for syntactic similarity; Nakayama et al., 2005; Vasishth, 2003; but cf. Uehara & Bradley, 1996 for phonological similarity). If both syntactic and phonological similarity effects adversely affect the processing of Turkish center-embeddings, the sentences in (13a, d), which have both high syntactic and high phonological similarity, would be the most difficult to process. The sentences in (13b, e) have low syntactic interference and high phonological interference, and thus, are predicted to be the second most difficult sentences to process. The sentences in (13c, f) have low syntactic interference and low phonological interference, and are predicted to be the easiest to process. In that case, the three levels of case interference variable are predicted to show the following pattern in processing (“>” indicates more difficult/longer time to process): High Syntactic – High Phonological > Low Syntactic – High Phonological > Low Syntactic – Low Phonological.

But recall from Chapter 2 that the studies investigating phonological similarity were inconclusive: whereas some studies showed evidence for increased processing difficulty (Nakayama et al., 2005 for Korean; Vasishth, 2003 for Hindi),

others reported null effects (Uehara & Bradley, 1996 for Korean). Thus, if syntactic similarity but not phonological similarity modulates the processing difficulty of Turkish center-embeddings, there will be no reliable difference between the sentences which are similar in terms of their syntactic similarity but differ in their phonological similarity. That is, the sentences with low syntactic and high phonological interference as in (13b, e) and those with low syntactic and low phonological interference as in (13c, f) would be processed with similar difficulty. In that case, the following pattern is predicted (">" indicates more difficult/longer time to process, and "=" indicates similar difficulty/similar time to process): High Syntactic – High Phonological > Low Syntactic – High Phonological = Low Syntactic – Low Phonological.

But note that the results of Experiment 1, in which syntactic case similarity was manipulated while phonological case similarity was held constant, showed that decreasing syntactic similarity among the subject NPs did not make it easier but made it more difficult to process Turkish center-embedded structures. If that was a genuine effect not influenced by the task being off-line or the use of factive alternating verbs, then, increasing syntactic similarity may not influence the processing of Turkish center-embeddings. If neither of case interference manipulations influences the processing difficulty of center embedded sentences in Turkish, there will be no reliable difference between the three levels of the variable, and they will show the following pattern ("=" indicates similar difficulty/similar to process): High Syntactic – High Phonological = Low Syntactic – High Phonological = Low Syntactic – Low Phonological. If phonological but not syntactic interference affects their processing, the three levels of the case interference variable will show the following pattern (">" indicates more difficult/longer time to process, and "="

indicates similar difficulty/similar to process): High Syntactic – High Phonological = Low Syntactic – High Phonological > Low Syntactic – Low Phonological.

Recall from Chapter 2 (and also from Experiment 2) that Fodor (2013) predicts that the difficulty associated with center-embedded sentences can be alleviated if the construction is phrased optimally by manipulating the lengths of these constituents in ways that would result in optimal and balanced phrases. The optimal prosodic phrasing for Turkish center-embeddings may be NP1 || NP6 || VP1 (see Section 3.3.2 for details). Fodor's predictions for a facilitative role of optimal prosodic phrasing in processing center-embedded structures were confirmed in English (Fodor & Nickels, 2011; Fodor et al., 2017; Fodor et al., 2019) and in Turkish (Experiment 2 of the present study). But all the previous studies, including Experiment 2 of the present study, tested the predictions of phrase length effects in processing center-embedded structures sentence-finally. Thus, it is not clear, without employing a methodology that informs on real-time parsing decisions, to determine if phrase length effects take place immediately, i.e., as the lengths of phrases are processed by participants. Eye-tracking methodology is rather suitable to investigate whether or not phrase lengths inform on-line parsing decisions because the participants would see the overall length of the sentences on the screen without disruption to the potentially projected prosody (cf. self-paced reading), but their on-line processing behavior on each word would also be measured. Thus, if phrasing Turkish center-embeddings optimally as NP1 || NP6 || VP1 eases their processing, the sentences in the Encouraging Phrase Lengths conditions as in (13a-c) will take shorter to read than those in the Discouraging Phrase Lengths conditions as in (13d-f).

If syntactic and phonological interference and phrase length effects interact, then sentences with low syntactic and low phonological interference and encouraging phrase lengths as in (13c) are predicted to be the easiest to process whereas those with high syntactic and high phonological interference and discouraging phrase lengths as in (13d) are predicted to be the most difficult to process. If only syntactic interference and phrase lengths effects interact, the sentences with low syntactic (both high and low phonological) interference and encouraging phrase lengths as in (13b-c) are predicted to be the easiest to process while those with high syntactic (and high phonological) interference and discouraging phrase lengths as in (13d) are predicted to the most difficult to process. If only phonological interference and phrase lengths effects interact, the sentences with low phonological interference (and low syntactic) interference and encouraging phrase lengths as in (13c) are predicted to be the easiest to process while those with high phonological (both high and low syntactic) interference and discouraging phrase lengths as in (13a-b) are predicted to the most difficult to process.

The above predictions will be examined for the 14th word in each sentence – the critical region – corresponding to VP1 of the 2-CE-RCs, *kur-duk-ları-nı* (set.up-VN-3PL.POSS-ACC), in (13a, d) or *kur-du-lar* (set.up-PF-3PL), in (13b, c, e, f), and for the 15th word – the spillover region – corresponding to the verb of the matrix clause, *san-dı-m* (think-PF-1SG) in (13a-f). The critical region was chosen as VP1 as it can inform on both case interference and phrase lengths effects. As was discussed in Chapter 2, the presence of a syntactically similar distractor NP, i.e., NP2, upon processing VP1 causes retroactive retrieval interference effects in retrieving the correct subject, NP1, for VP1. For phrase lengths, upon processing VP1, both

(expected) prosodic boundaries would have been projected onto the sentence, and hence, the effects of the optimal phrasing could be better captured at that region.

As mentioned above, the eye-tracking methodology will allow to observe the time-course of the effects as it provides data from both the critical and spill-over regions, and about both early and later stages of processing. If one factor, i.e., case interference or phrase lengths, take effect sooner than the other, its effects will be revealed at an earlier region, i.e., the critical region, and/or in early measures. Conversely, if one factor influences processing later than the other, its effects will be observed at a later region, i.e., the spill-over region, and/or in later measures. If both factors affect processing at the same time, their effects will be observed at the same region and in similar measures.

3.4.4 Procedure

The eye-tracking data were collected in a quiet laboratory. The eye-movements of the participants as they read the experimental stimuli were recorded via SR EyeLink 1000 Plus (SR Research, Mississauga, Ontario, Canada). Although viewing was binocular, only data from the right eye was recorded for analyses. Before starting the experiment, the participants were informed about the procedure and were asked to read the sentences at their normal rate and to answer the comprehension questions that followed. They were also told that they were taking part in a reading experiment, but they were not informed about the true purposes of the study. The participants were seated 55 centimeters away from the computer screen and rested their chin on a chin rest to minimize head movements.

A calibration procedure preceded the experiment. During calibration, participants were asked to fixate on a grid of nine fixation targets in random

succession. The calibration procedure was followed by a validation procedure to test the accuracy of the calibration. Participants started the experiment only after successful calibration and validation. Before each trial, a fixation dot (i.e., a drift correction) appeared near the left-corner of the sentence. Once the participant fixated on this dot, the experimenter confirmed the drift check, and the computer displayed the target sentence, with the first character of this sentence replacing the fixation dot. If there were any problems with drift-check, the participants went through a re-calibration process.

The text stimuli were left-aligned and were presented in a single line, using a Courier New, size 14 font, printed in black on a white background. The characters all had the same width. Once the participants finished reading each sentence, they left-clicked the mouse, and a comprehension question for the sentence that they had just read was presented on a separate screen. They also left-clicked the mouse to answer the comprehension questions. The participants did not receive feedback about the accuracy of their answers to the comprehension questions. There were five practice sentences before the experiment to familiarize the participants with the experimental procedure. Any questions that the participants might have had were answered after the practice session. The participants started the experiment themselves by pressing the space bar. The whole experiment, including calibration and validation, took 25-30 minutes on average to finish.

3.4.5 Data Analysis

Six standard eye-tracking measures, namely first fixation duration, gaze duration, regression path duration, rereading duration, total duration and probability of regression out were used for data analyses (Clifton, Staub & Rayner, 2007;

Liversedge, Paterson, & Pickering, 1998; Rayner et al., 1989). First fixation duration is the time of fixating the region for the first time. Gaze duration, which is also referred to as first pass reading time when the region of interest has more than one word (Clifton et al., 2007; Liversedge et al., 1998; Rayner et al., 1989), is the sum of all fixations in a region before the reader leaves the region, either to the left or to the right (Rayner & Duffy, 1986). First fixation duration and gaze duration are referred to as early measures as they usually indicate the difficulty that is experienced upon immediate processing of the region (Liversedge et al., 1998; Rayner et al., 1989). Regression path duration, which is also referred to as go-past time, is the sum of all fixations starting from the first to the last fixation in a region until the reader moves to the right (Liversedge et al., 1998). This measure gives the reading time that a reader spends in detecting a difficulty and rereading the prior text before moving to the right. Rereading duration is the time that is spent in rereading the prior text after encountering a difficulty, before moving to the right (Liversedge et al., 1998). Total reading time is a combination of initial and rereading times and is the sum of all fixations that are made within a region (Liversedge et al., 1998). Probability of regression out is the probability of a reader to make a regressive saccade that ends the first pass or gaze duration reading times, and it is taken as an indication of difficulty in processing a region (Liversedge et al., 1998). Total reading time, regression path duration, rereading duration and probability of regression out are referred to as late measures since they indicate relatively later effects of experimental manipulation on processing (Liversedge et al., 1998). It is suggested to use both early and late measures in order to increase the possibility of detecting any effects (e.g., Liversedge et al., 1998).

Before the analyses of these measures, the data were cleaned for extremely short or long durations. Fixations below 80 milliseconds (ms) were merged with nearby fixations because word recognition is assumed to take longer than 80 ms (Rayner & Pollatsek, 1989). Also, fixations above 800 ms were excluded from the main analyses because information of processing during reading is argued to take shorter than 800 ms (Rayner et al., 1989). Following Vasishth et al. (2010), the RTs that were greater than 2000 ms in all the five RT measures were removed as such long RTs may not reflect on-line processing events.

The data were analyzed using mixed effects linear regression models (for first fixation duration, gaze duration, regression path duration, rereading duration and total duration) or logistic regression models (for probability of regression out) (Bates et al., 2015). One advantage of linear mixed and logistic regression models is that it is possible to include both subject and item level variance in the same models (Baayen et al., 2008). All statistical analyses were carried out on the R statistical computing software (R Development Core Team, 2020) using the *lme4* (Bates & Maechler, 2013) and *languageR* packages (Baayen, 2013). The analyses that are reported here were also conducted on log transform of RT data without the exclusion of RTs above 2000 ms. These analyses on the log-transformed data produced a similar pattern of results to those reported here. For simplicity, in the following I report only the analyses on untransformed data.

Model building steps were the same as in previous experiments. In the retained models for each eye-tracking measure, data points with standardized residuals above or below 2.5 standard deviations were eliminated from the analyses (Baayen & Milin, 2010). Moreover, overly influential subjects, items and data points were inspected, using the *influence.ME* function (Nieuwenhuis, Grotenhuis, &

Pelzer, 2012). Both Cook's distance values and plots were employed in this inspection. The influential subjects, items or data points that overly influenced the models were eliminated from the data, and the models were re-fit after these steps.

In the analyses, both the critical and the spill-over regions were examined for the six eye-tracking measures that are described above.

3.4.6 Results

The data from two participants were excluded from the analyses due to calibration problems during data collection. The data inclusion criterion for the remaining forty-two participants was 60%, and all the remaining forty-two participants passed this criterion. The participants' overall comprehension accuracy was 84% on average, confirming that they were actively reading the stimuli for comprehension.

In the analyses for both the critical region and the spill-over region, Case Interference and Phrase Lengths were fixed effects (the predictor variables); and subjects and items were random effects. Case Interference had three levels; High Syntactic – High Phonological Interference as in (13a, d), Low Syntactic - High Phonological Interference as in (13b, e) and Low Syntactic - Low Phonological Interference as in (13c, f). Phrase Lengths had two levels; Encouraging Phrase Lengths as in (13a-c) and Discouraging Phrase Lengths as in (13d-f). The results are reported below separately for the critical region and the spillover region.

3.4.6.1 The critical region

Two analyses were conducted for the critical region. In the first analysis, the main predictors were Case Interference (High Syntactic – High Phonological, Low Syntactic – High Phonological and Low Syntactic – Low Phonological) and Phrase

Lengths (Encouraging Phrase Lengths and Discouraging Phrase Lengths). In this analysis, Low Syntactic – Low Phonological Interference condition was taken as the baseline, and fixation durations and probability of regression out for the other two conditions (High Syntactic – High Phonological and Low Syntactic – High Phonological) were compared to it. This analysis was conducted to observe how each level of case-interference manipulation manifested in the data. Note that in these analyses the low phonological interference condition was compared to the two high phonological interference conditions separately. In the second analyses, Phrase Lengths and Case Interference predictors were used, but only the High Syntactic – High Phonological and Low Syntactic – High Phonological levels of Case Interference were included to observe the effects of syntactic interference when phonological interference was controlled (High in both levels). I report on these two analyses separately.

Table 7 below summarizes the mean and standard error values of the six conditions across the six eye-tracking measures for the critical region after the elimination of extremely short and long durations and the RTs that were greater than 2000 ms (see Section 3.4.5 for the details of data cleaning procedure). Across both the critical and the spill-over region, this procedure affected 3.3% of the data. Here and henceforth, the following abbreviations will be used for the six eye-tracking measures: FFD for fixation duration, GD for gaze duration, RPD for regression path duration, RRD for rereading duration, TD for total duration and PRO for probability of regression. Also, the following abbreviations will be used for the six conditions in the tables: HS-HP for High Syntactic – High Phonological Interference conditions, LS-HP for Low Syntactic – High Phonological Interference conditions, LS-LP for

Low Syntactic – Low Phonological Interference conditions, ENC for Encouraging Phrase Lengths conditions and DISC for Discouraging Phrase Lengths conditions.

Table 7. Mean Values for the Six Conditions with Standard Errors in Parentheses for the Six Eye-tracking Measures at the Critical Region

	FFD	GD	RPD	RRD	TD	PRO
HS-HP, ENC	231 (6)	380 (14)	428 (19)	315 (31)	661 (31)	.10 (.02)
LS-HP, ENC	233 (5)	318 (12)	363 (17)	253 (26)	565 (28)	.11 (.02)
LS-LP, ENC	238 (7)	333 (12)	418 (24)	275 (30)	602 (30)	.15 (.03)
HS-HP, DISC	239 (6)	409 (16)	554 (27)	434 (36)	793 (35)	.20 (.03)
LS-HP, DISC	247 (8)	347 (14)	462 (23)	327 (32)	633 (31)	.21 (.03)
LS-LP, DISC	239 (6)	324 (13)	417 (21)	352 (32)	648 (31)	.19 (.03)

Before the main analyses, for each eye-tracking measure, the effect of Trial number was examined to reveal longitudinal effects of familiarization or fatigue (i.e., the gradual change in the reading times or probability of regression out of the region due to familiarization or tiredness) (Baayen, 2008; Baayen, et al., 2008). The results showed that the fixation durations became gradually longer towards the end of the experiment for GD (β = .54, *SE* = .19, *t* = 2.85, $p < .01$) and RPD (β = .90, *SE* = .31, *t* = 2.90, $p < .01$), shorter towards the end of the experiment for RRD (β = -1.17, *SE* = .40, *t* = -2.91, $p < .01$). Thus, in building a model for the following analyses for GD, RPD and RRD, Trial number was included as one of the predictor variables.

The first set of analyses included Case Interference and Phrase Lengths as the predictor variables. The Low Syntactic – Low Phonological condition was taken as the baseline, and the High Syntactic – High Phonological and Low Syntactic – High Phonological conditions were compared to that condition in these analyses. The comparison of the Low Syntactic – High Phonological Interference to the Low Syntactic – Low Phonological conditions would reveal phonological interference effects when syntactic interference was controlled, and the comparison of the High

Syntactic – High Phonological Interference to the Low Syntactic – Low Phonological conditions would allow us to observe the effects of both phonological and syntactic interference effects.

Analyses with Case Interference as a predictor variable for gaze duration, regression path duration, rereading duration and total duration showed that the participants read the critical region in the High Syntactic – High Phonological conditions (13a, d) in a significantly longer time than that in the Low Syntactic – Low Phonological conditions (13c, f) (GD: β = 52.51, *SE* = 12.45, *t* = 4.22, *p* < .001; RPD: β = 82.47, *SE* = 18.13, *t* = 4.55, *p* < .001; RRD: β = 49.07, *SE* = 26.25, *t* = 1.87, *p* = .06; TD: β = 105.22, *SE* = 26.83, *t* = 3.92, *p* < .001; FFD: β = -1.57, *SE* = 5.93, *t* = -.26, *p* = .79). The proportions of regressions out of the critical region was unexpectedly lower in the High Syntactic – High Phonological conditions (13a, d) than in the Low Syntactic – Low Phonological conditions (13c, f) β = -.38, *SE* = .19, *z* = -1.95, *p* = .05. This analysis showed no reliable difference between the Low Syntactic – High Phonological (13a, d) and Low Syntactic – Low Phonological (13c, f) in any of the six measures (*t*'s ≤ 1.52, *p*'s ≥ .13; and PRO: *z* = -1.16, *p* = .24). Note that in the retained models 1 subject, 1 item and 3 data points in FFD; 1 subject and 5 data points in GD; 2 subjects and 6 data points in RPD; 5 data points in RRD, 2 data points in TD, 3 subjects in PRO deviated from group statistics; and thus, eliminated from the analyses.

Analyses with Phrase Lengths as a predictor showed for first fixation duration, regression path duration, rereading duration and total duration that the critical region in the Discouraging Phrase Lengths conditions as in (13d-f) took significantly longer to read than that in the Encouraging Phrase Lengths conditions as in (13a-c) (FFD: β = 13.60, *SE* = 4.54, *t* = 3.00, *p* < .01; RPD: β = 74.48, *SE* =

14.77, t = 5.04, p < .001; RRD: β = 87.70, SE = 21.49, t = 4.08, p < .001; TD: β = 84.40, SE = 21.87, t = 3.86, p < .001; GD: β = 14.52, SE = 10.12, t = 1.43, p = .15). In addition, the participants were more likely to regress out of the critical region in the Discouraging Phrase Lengths conditions than in the Encouraging Phrase Lengths conditions, β = .39, SE = .16, z = 2.51, p < .05).

For regression path duration, rereading duration, total duration and probability of regression out, the complex model including two predictors explained the data better than the simple model with Case Interference as a predictor variable (RPD: $\chi 2$ (1) = 21.24, p < .001; RRD: $\chi 2$ (1) = 17.61, p < .001; TD: $\chi 2$ (1) = 16.10, p < .001; PRO: $\chi 2$ (1) = 6.25, p < .05). In addition, for gaze duration, regression path duration, rereading duration and total duration, the complex model including two predictors explained the data better than the simple model with Phrase Lengths as a predictor variable (GD: $\chi 2$ (1) = 35.93, p < .001; RPD: $\chi 2$ (1) = 20.47, p < .001; RRD: $\chi 2$ (1) = 10.56, p < .01; TD: $\chi 2$ (1) = 25.67, p < .001). And for regression path duration and probability of regression out, the more complex model including the interaction of the two predictors explained the data better than the complex model with two predictors (RPD: $\chi 2$ (1) = 10.83, p < .01; PRO: $\chi 2$ (1) = 7.02, p < .05).

In order to understand how the Case Interference and Phrase Lengths predictors may have contributed to the data in the complex models with two predictors or the complex models with the interaction, the data were split, and the effects of Case Interference were examined in each Encouraging and Discouraging Phrase Lengths conditions individually for gaze duration, regression path duration, rereading duration, total duration and probability of regression out. For the relevant eye-tracking measures, Table 8 shows the statistics for the Encouraging Phrase

Lengths conditions, and Table 9 shows the statistics for the Discouraging Phrase Lengths conditions.

Table 8. Comparison of High Syntactic – High Phonological and Low Syntactic – High Phonological Conditions to Low Syntactic – Low Phonological Conditions for Sentences with Encouraging Phrase Lengths

		β	*SE*	*t*	*p*
GD	HS-HP to LS-LP	37.83	16.78	2.56	< .05
	LS-HP to LS-LP	-19.73	16.63	-1.18	.24
RPD	HS-HP to LS-LP	32.07	22.30	1.44	.15
	LS-HP to LS-LP	-33.93	22.18	-1.53	.13
RRD	HS-HP to LS-LP	5.62	34.60	.16	.87
	LS-HP to LS-LP	-50.30	34.56	-1.46	.15
TD	HS-HP to LS-LP	56.03	35.08	1.60	.11
	LS-HP to LS-LP	-44.31	34.69	-1.28	.20
PRO	HS-HP to LS-LP	-.75	.28	-2.63	< .001
	LS-HP to LS-LP	-.79	.29	-2.72	< .001

Table 9. Comparison of High Syntactic – High Phonological and Low Syntactic – High Phonological Conditions to Low Syntactic – Low Phonological Conditions for Sentences with Discouraging Phrase Lengths

		β	*SE*	*t*	*p*
GD	HS-HP to LS-LP	68.23	18.30	3.73	< .001
	LS-HP to LS-LP	27.19	18.48	1.47	.14
RPD	HS-HP to LS-LP	124.32	27.93	4.45	< .001
	LS-HP to LS-LP	34.81	28.39	1.23	.22
RRD	HS-HP to LS-LP	93.11	40.11	2.32	< .05
	LS-HP to LS-LP	-26.95	41.06	-.66	.51
TD	HS-HP to LS-LP	144.31	40.99	3.52	< .001
	LS-HP to LS-LP	-9.93	40.98	-.24	.81
PRO	HS-HP to LS-LP	-.05	.26	-.19	.85
	LS-HP to LS-LP	.22	.26	.85	.40

Table 10 summarizes the pattern of results in these analyses.

Table 10. Reading Time and Probability of Regression Out Data Pattern for the Critical Region, > indicates longer reading time or higher probability of regression out; = indicates no significant difference in reading time or probability of regression out. All inequalities in the table are confirmed at $p < .05$ or smaller.

	ENC	DISC
GD	HS-HP > LS-LP	HS-HP > LS-LP
	LS-HP = LS-LP	LS-HP = LS-LP
RPD	HS-HP = LS-LP	HS-HP > LS-LP
	LS-HP = LS-LP	LS-HP = LS-LP
RRD	HS-HP = LS-LP	HS-HP > LS-LP
	LS-HP = LS-LP	LS-HP = LS-LP
TD	HS-HP = LS-LP	HS-HP > LS-LP
	LS-HP = LS-LP	LS-HP = LS-LP
PRO	HS-HP > LS-LP	HS-HP = LS-LP
	LS-LP > HS-HP	LS-HP = LS-LP

The above analyses overall revealed that increasing syntactic interference when phonological interference was not controlled for resulted in longer RTs or higher probability of regression out in the High Syntactic – High Phonological conditions as in (13a, d) than in the Low Syntactic – Low Phonological conditions (13c, f). This was the case both in the Encouraging and Discouraging Phrase Lengths conditions. However, manipulating phonological interference while controlling for syntactic interference did not significantly affect the participants' reading behavior, i.e., similar behavior in the Low Syntactic – High Phonological conditions as in (13b, e) and the Low Syntactic – Low Phonological conditions as in (13c, f). Furthermore, the results showed that the readers spent longer time in reading the critical region or were more likely to regress out of the critical region in the Discouraging Phrase Lengths conditions as in (13d-f) than in the Encouraging Phrase Lengths conditions as in (13a-c).

In the second set of analysis, the Phrase Lengths and Case Interference predictors were used, but only the High Syntactic – High Phonological and Low Syntactic – High Phonological levels of Case Interference were included to observe syntactic interference effects when phonological interference was controlled for.

Analyses with Case Interference as a predictor showed for gaze duration, regression path duration, rereading duration and total duration that the participants read the critical region in the High Syntactic Interference conditions as in (13a, d) in a significantly longer time than that in the Low Syntactic Interference conditions as in (13b, e) (GD: β = 42.67, *SE* = 12.45, *t* = 3.43, *p* < .001; RPD: β = 63.62, *SE* = 15.27, *t* = 3.67, *p* < .001; RRD: β = 64.10, *SE* = 21.45, *t* = 2.99, *p* < .01 and TD: β = 142.69, *SE* = 26.54, *t* = 5.38, *p* < .001; FFD: β = -4.98., *SE* = 5.40, *t* = -.92, *p* = .36; PRO: β = -.20, *SE* = .21, *z* = -.96, *p* = .34). Since the results for the Phrase Lengths predictor were similar to those in the first set of analysis, they will not be reported here. Note that in the retained models 3 subjects and 6 data points in FFD; 1 subject, 1 item and 5 data points in GD; 1 subject and 6 data points in RPD; 2 subjects and 5 data points in RRD, 2 data points in TD, 3 subjects and 1 item in PRO deviated from group statistics; and thus, eliminated from the analyses.

The complex model with the two predictors (Case Interference and Phrase Lengths) explained the data better than the simple model with Case Interference as a predictor variable for RPD ($\chi 2$ (1) = 20.53, *p* < .001), RRD ($\chi 2$ (1) = 17.53, *p* < .001), TD ($\chi 2$ (1) = 15.86, *p* < .001) and PRO ($\chi 2$ (1) = 6.22, *p* < .05). Similarly, the complex model with two predictors explained the data better than the simple model with Phrase Lengths as a predictor variable for GD ($\chi 2$ (1) = 24.85, *p* < .001), RPD ($\chi 2$ (1) = 15.75, *p* < .001), RRD ($\chi 2$ (1) = 10.40, *p* < .01) and TD ($\chi 2$ (1) = 23.24, *p* < .001). To better understand the contribution of the Case Interference and Phrase Lengths predictors to the data separately, the data were split, and the effects of syntactic interference were examined in each Encouraging and Discouraging Phrase Lengths conditions individually for gaze duration, regression path duration, rereading duration, total duration and probability of regression out. For the relevant

eye-tracking measures, Table 11 shows the statistics for the Encouraging Phrase Lengths conditions, and Table 12 shows the statistics for the Discouraging Phrase Lengths conditions.

Table 11. Comparison of High Syntactic – High Phonological Conditions to Low Syntactic – High Phonological Conditions for Sentences with Encouraging Phrase Lengths

	β	*SE*	*t*	*p*
GD	52.03	16.40	3.17	< .01
RPD	55.33	24.01	2.31	< .05
RRD	46.04	33.52	1.37	.17
TD	112.86	33.88	3.3	< .001
PRO	-.01	.31	-.04	.97

Table 12. Comparison of Low Syntactic – High Phonological Conditions to High Syntactic – High Phonological Conditions for Sentences with Discouraging Phrase Lengths

	β	*SE*	*t*	*p*
GD	34.10	18.76	1.82	.07
RPD	79.94	28.28	2.83	< .01
RRD	102.41	41.85	2.45	< .05
TD	170.17	41.21	4.13	< .001
PRO	-.33	.28	-1.19	.23

The results showed the pattern in Table 13.

Table 13. Reading Time and Probability of Regression Out Data Pattern for the Critical Region, > indicates longer reading time or higher probability of regression out; = indicates no significant difference in reading time or probability of regression out. All inequalities in the table are confirmed at p <.05 or smaller.

	ENC	DISC
GD	HS-HP > LS-HP	HS-HP = LS-HP
RPD	HS-HP > LS-HP	HS-HP > LS-HP
RRD	HS-HP = LS-HP	HS-HP > LS-HP
TD	HS-HP > LS-HP	HS-HP > LS-HP
PRO	HS-HP = LS-HP	HS-HP = LS-HP

The first and second sets of analyses demonstrated that decreasing syntactic interference and encouraging phrase lengths led to shorter reading time or a decreased probability of regression out whereas phonological interference did not

affect the participants' reading behavior. Follow-up pair-wise analyses were conducted to compare the four conditions manipulating syntactic interference and prosodic phrase lengths to test the specific predictions for the interaction of the two variables. The multiple comparisons were conducted with Tukey's Honest Significance Test (HST) for the measures with significant effects of both variables or their interaction. Table 14 below presents the results of the multiple comparisons. The variables were entered in the analyses in the order presented at the most left-hand column.

Table 14. *t*- or *z*-values for Multiple Comparisons for the Reading Time and Probability of Regression Out Data Pattern for the Critical Region, * indicates significance at $p < .05$ or smaller. The negative sign in front of the t/z values indicates shorter reading time or a lower probability of regression out for the first condition in the most left-hand column.

	GD	RPD	RRD	TD	PRO
HS-HP, DISC to HS-HP, ENC	1.06	4.33*	3.72*	3.47*	2.01
HS-HP, DISC to LS-HP, ENC	4.38*	7.04*	5.23*	6.19*	2.03
HS-HP, ENC to LS-HP, DISC	1.29	-.85	-.37	.64	-3.02*
LS-HP, DISC to LS-HP, ENC	1.98	3.49*	1.82	2.05	3.06*

Overall, the analyses on the critical region showed that increasing syntactic interference led to longer RTs in both Encouraging and Discouraging Phrase Lengths conditions both when phonological interference was controlled for, i.e., longer RTs in the High Syntactic – High Phonological conditions as in (13a, d) than in the Low Syntactic – High Phonological conditions as in (13b, e), and when it was not controlled for, i.e., longer RTs in the High Syntactic – High Phonological conditions as in (13a, d) than in the Low Syntactic – Low Phonological conditions as in (13c, f). However, manipulating only phonological interference, i.e., when syntactic interference was controlled for, did not influence the RTs, i.e., similar RTs in the Low Syntactic – High Phonological conditions as in (13b, e) and the Low Syntactic – Low Phonological conditions as in (13c, f). Moreover, the analyses showed that there

were longer RTs and a higher probability of regression out of the region in the Discouraging Phrase Lengths conditions as in (13d-f) than in the Encouraging Phrase Lengths conditions as in (13a-c).

The pairwise comparisons revealed an interaction between the two variables in later measures: the High Syntactic – High Phonological, Discouraging Phrase Lengths condition as in (13d) was the slowest to read among the four conditions (in regression path duration, rereading duration and total duration), and the Low Syntactic – High Phonological, Encouraging Phrase Lengths condition as in (13b) was the fastest to read (in regression path duration). The interaction can be summarized to show the following pattern: High Syntactic – High Phonological, Discouraging Phrase Lengths > Low Syntactic – High Phonological, Discouraging Phrase Lengths = High Syntactic – High Phonological, Encouraging Phrase Lengths > Low Syntactic – High Phonological, Encouraging Phrase Lengths.

3.4.6.2 The spill-over region

As in the critical region, two sets of analyses were conducted for the spill-over region. In the first analysis, the main predictors were Case Interference (High Syntactic – High Phonological, Low Syntactic – High Phonological and Low Syntactic – Low Phonological) and Phrase Lengths (Encouraging Phrase Lengths and Discouraging Phrase Lengths). In this analysis, Low Syntactic – Low Phonological Interference condition was taken as the baseline, and fixation durations and probability of regression out for the other two conditions (High Syntactic – High Phonological and Low Syntactic – High Phonological) were compared to it. This analysis was conducted to observe how each level of case-interference manipulation manifested in the data. Note that in these analyses the low phonological interference

condition was also compared to the two high phonological interference conditions. In the second analyses, Phrase Lengths and Case Interference predictors were used, but only the High Syntactic – High Phonological and Low Syntactic – High Phonological levels of Case Interference were included to observe the effects of syntactic interference when phonological interference was controlled (High in both levels). I report on these two analyses separately.

Table 15 below summarizes the mean and standard error values of the six conditions across the six eye-tracking measures for the critical region after the elimination of extremely short and long durations, and the RTs that were greater than 2000 ms (see Section 3.4.5 for the details of data cleaning procedure).

Table 15. Mean Values for Six Conditions with Standard Errors in Parentheses for the Six Eye-tracking Measures at the Spill-over Region

	FFD	GD	RPD	RRD	TD	PRO
HS-HP, ENC	244 (7)	283 (10)	373 (27)	146 (18)	408 (19)	.15 (.03)
LS-HP, ENC	238 (6)	267 (9)	332 (18)	180 (23)	439 (24)	.19 (.03)
LS-LP, ENC	239 (7)	290 (11)	378 (24)	178 (26)	447 (25)	.19 (.04)
HS-HP, DISC	247 (7)	280 (19)	434 (26)	210 (27)	463 (24)	.26 (.04)
LS-HP, DISC	249 (7)	297 (11)	416 (27)	170 (22)	466 (26)	.26 (.04)
LS-LP, DISC	251 (8)	278 (11)	416 (27)	192 (22)	465 (22)	.24 (.04)

Similar to the analyses for the critical region, before the main analyses, the relationship between the six eye-tracking measures and Trial was examined. The results showed that the RTs became gradually shorter towards the end of the experiment for RRD (β = -.83, SE = .30, t = -2.82, $p < .01$) and TD (β = -.97, SE = .30, t = -3.20, $p < .01$). Thus, in building a model for the analyses for RRD and TD, Trial number was included as one of the predictor variables.

In the first set of analyses Case Interference and Phrase Lengths were included as the predictor variables. The Low Syntactic – Low Phonological condition was taken as the baseline, and the High Syntactic – High Phonological and Low Syntactic – High Phonological conditions were compared to that condition in these

analyses. The comparison of the Low Syntactic – High Phonological Interference to the Low Syntactic – Low Phonological conditions would reveal phonological interference effects when syntactic interference was controlled, and the comparison of the High Syntactic – High Phonological Interference to the Low Syntactic – Low Phonological conditions would allow us to observe the effects of both phonological and syntactic interference effects.

Analyses with Case Interference as a predictor variable showed that there was no reliable difference between reading times or probability of regression out for the spill-over region in the High Syntactic – High Phonological (13a, d) and Low Syntactic – Low Phonological conditions (13c, f) for any of the six measures (t's ≤ 1.05, p's ≥ .29 and PRO: z = -.57, p = .57). Similarly, the comparison between the Low Syntactic – High Phonological (13b, e) and Low Syntactic – Low Phonological (13c, e) conditions indicated no significant difference for any of the six measures (t's ≤ 1.74, p's ≥ .08 and PRO: z = -1.15, p = .25). Analyses with Phrase Lengths as a predictor showed for regression path duration that the spill-over region in the Discouraging Phrase Lengths conditions as in (13d-f) was read in a significantly longer time than that in the Encouraging Phrase Lengths conditions as in (13a-c) (RPD: β = 50.62, SE = 20.10, t = 2.52, p < .05) (all other measures: t's ≤ 1.43, p's ≥ .15 and PRO: z = 1.27, p = .20). Note that in the retained models 1 subject and 1 item in RPD and 1 item in TD deviated from group statistics; and thus, eliminated from the analyses.

For regression path duration and total duration, the complex model including two predictors explained the data better than the simple model with Case Interference as a predictor variable (RPD: $\chi 2$ (1) = 10.24, p < .01; TD: $\chi 2$ (1) = 4.03, p < .05). In order to understand how Case Interference and Phrase Lengths predictors may have

contributed to the data in the complex models with two predictors, the data were split, and the effects of syntactic and phonological interference were examined in each Encouraging and Discouraging Phrase Lengths conditions individually for regression path duration and total duration. For the relevant eye-tracking measures, Table 16 shows the statistics for the Encouraging Phrase Lengths condition, and Table 17 shows the statistics for the Discouraging Phrase Lengths condition.

Table 16. Comparison of High Syntactic – High Phonological and Low Syntactic – High Phonological Conditions to Low Syntactic – Low Phonological Conditions for Sentences with Encouraging Phrase Lengths

		β	*SE*	*t*	*p*
RPD	HS-HP to LS-LP	3.75	33.80	.11	.91
	LS-HP to LS-LP	-67.87	33.62	-2.02	< .05
TD	HS-HP to LS-LP	-19.37	29.33	-.66	.51
	LS-HP to LS-LP	-24.94	29.26	-.85	.40

Table 17. Comparison of High Syntactic – High Phonological and Low Syntactic – High Phonological Conditions to Low Syntactic – Low Phonological Conditions for Sentences with Discouraging Phrase Lengths

		β	*SE*	*t*	*p*
RPD	HS-HP to LS-LP	12.58	36.67	.34	.73
	LS-HP to LS-LP	-16.09	36.09	-.45	.66
TD	HS-HP to LS-LP	-6.97	28.39	-.25	.81
	LS-HP to LS-LP	-22.80	28.18	-.81	.42

Table 18 summarizes the results of the pairwise comparisons.

Table 18. Reading Time Data Pattern for the Critical Region, < indicates shorter reading time, = indicates no significant difference in reading time. All inequalities in the table are confirmed at p <.05 or smaller.

	ENC	DISC
RPD	HS-HP = LS-LP	HS-HP = LS-LP
	LS-HP < LS-LP	LS-HP = LS-LP
TD	HS-HP = LS-LP	HS-HP = LS-LP
	LS-HP = LS-LP	LS-HP = LS-LP

The above analyses demonstrated that increasing syntactic interference or phonological interference did not influence the participants' reading behavior either

in the Encouraging or the Discouraging Phrase Lengths conditions. But prosodic phrase lengths effects were observed for regression path duration with longer RTs for the Discouraging Phrase Lengths conditions as in (13d-f) than the Encouraging Phrase Lengths conditions as in (13a-c).

In the second set of analysis, the Phrase Lengths and Case Interference predictors were used, but only the High Syntactic – High Phonological and Low Syntactic – High Phonological levels of Case Interference were included to observe syntactic interference effects when phonological interference was controlled for.

Analyses with Case Interference as a predictor showed that there was no reliable difference between the reading times for the spill-over region in the High Syntactic – High Phonological Interference conditions as in (13a, d) and the Low Syntactic – High Phonological Interference conditions as in (13b, e) for any of the six measures (t's ≤ 1.60, p's $\geq .11$; and PRO: $z = -.65$, $p = .52$). Since the results for the Phrase Lengths predictor were similar to those in the first set of analysis, they will not be reported here. Note that in the retained models 1 item and 6 data points in GD; 1 subject, 1 item, 5 data points in RPD; 1 item, 5 data points in RRD; 1 item, 4 data points in TD deviated from group statistics; and therefore, eliminated from the analyses.

The complex model with two predictors (Case Interference and Phrase Lengths) explained the data better than the simple model with Case Interference as a predictor variable for RPD ($\chi 2$ (1) = 10.30, $p < .01$) and TD ($\chi 2$ (1) = 3.77, $p = .05$). And the model with the interaction explained the data marginally better than the model with both predictors for RRD ($\chi 2$ (1) = 3.15, $p = .07$). To understand how the Case Interference and Phrase Lengths predictors contributed to the data separately, the data were split, and the effects of syntactic interference were examined in each

Encouraging and Discouraging Phrase Lengths conditions individually for regression path duration, rereading duration and total duration. For the relevant eye-tracking measures, Table 19 shows for the statistics for Encouraging Phrase Lengths condition, and Table 20 shows the statistics for Discouraging Phrase Lengths condition.

Table 19. Comparison of High Syntactic – High Phonological and to Low Syntactic – High Phonological Conditions for Sentences with Encouraging Phrase Lengths

	β	*SE*	*t*	*p*
RPD	29.18	28.77	1.02	.31
RRD	-2.60	24.90	-.10	.92
TD	13.82	27.70	.50	.62

Table 20. Comparison of Low Syntactic – High Phonological and to High Syntactic – High Phonological Conditions for Sentences with Discouraging Phrase Lengths

	β	*SE*	*t*	*p*
RPD	42.37	35.05	1.21	.23
RRD	32.03	25.36	1.26	.21
TD	4.53	27.09	.17	.87

The results showed the pattern in Table 21.

Table 21. Reading Time Data Pattern for the Critical Region. > indicates longer reading time; = indicates no significant difference in reading time. All equalities in the table are confirmed at $p > .05$.

	ENC	DISC
RPD	HS-HP = LS-HP	HS-HP = LS-HP
RRD	HS-HP = LS-HP	HS-HP = LS-HP
TD	HS-HP = LS-HP	HS-HP = LS-HP

Overall, the analyses for the spill-over region showed that there were no effects of syntactic or phonological interference either in the Encouraging or Discouraging Phrase Lengths conditions. But prosodic phrase lengths were observed in the spill-over region, for regression path duration, in which the RTs were longer in the Discouraging Phrase Lengths conditions as in (13d-f) than in the Encouraging Phrase Lengths conditions as in (13a-c).

3.4.7 Discussion

Experiment 3 explored if syntactic and phonological interference and/or prosodic phrase lengths influenced the processing of Turkish center-embeddings. There were three main findings. First, unlike the findings of Experiment 1 which failed to provide evidence for the facilitative role of decreased syntactic similarity among the NPs on center-embedding difficulty, the results of Experiment 3 showed that the sentences with less syntactic case similarity among the subject NPs were easier to process than those with higher syntactic case similarity. There were no interference effects for phonological case similarity though: the sentences with a higher number of phonologically similar NPs were as easy as those with a lower number of phonologically similar NPs to process. Third, similar to the results in Experiment 2, phrase lengths encouraging the optimal phrasing of center-embedded constructions as NP1 || NP6 || VP1 eased their processing. These results suggest that the processing difficulty of Turkish center-embeddings can be alleviated with decreased syntactic similarity and with phrase lengths that encourage their optimal phrasing.

For syntactic interference there were significant effects only in the critical region; there was no reliable effect in the spill-over region. Specifically, there was a consistent slow-down in reading and an increased probability of regression out of the region for the sentences with higher syntactic similarity. This was the case when the high syntactic interference conditions were compared to both the low syntactic interference conditions which controlled for phonological case similarity and the low syntactic interference which did not control for phonological similarity. This finding was revealed in both early stages of processing such as gaze duration and later stages of processing such as regression path duration, rereading duration, total duration and probability of regression out. For phonological similarity when syntactic similarity

was kept constant, there was no reliable between the high and low phonological case interference conditions either in the critical or in the spill-over region. This also presents evidence that the difference that was observed between the high and low syntactic case interference conditions when phonological similarity was not controlled was due to syntactic similarity effects. Hence, these results show that increasing syntactic similarity, but not phonological similarity, on subject NPs negatively affected the processing of Turkish center-embeddings. The pattern of data for case interference can be summarized as: High Syntactic – High Phonological > Low Syntactic – High Phonological = Low Syntactic – Low Phonological (where ">" indicates more difficult/longer time to process, and "=" indicates similar difficulty/similar time to process). Thus, the data overall support that the difficulty of Turkish center-embeddings can be eased with decreased syntactic similarity (Lewis & Nakayama, 1999; 2002; Uehara, 2003; Uehara & Bradley, 1996), but not with decreased phonological similarity (Nakayama et al., 2005; Vasishth, 2003; but cf. Uehara & Bradley, 1996).

The null effect of phonological interference is in line with Uehara and Bradley's (1996) findings for Korean, but it contradicts with the findings for Hindi in Vasishth (2003) and for Korean in Nakayama et al. (2005). The null findings on phonological interference in the present study can be attributed to (i) the level of embeddings in the experimental stimuli, (ii) the syntactic dissimilarity of the NPs manipulated for phonological interference or (iii) that phonological interference may not cause similarity-based interference effects at all (e.g., Obata, Lewis, Epstein, Bartek, & Boland, 2010). Whereas Nakayama et al. and Vasishth demonstrated phonological interference effects only on singly center-embedded structures, no phonological interference effects were found in Uehara and Bradley's study which

also employed doubly center-embeddings in addition to singly center-embeddings. The present study also employed doubly center-embeddings nested as a complement clause inside another matrix clause. The results on singly center-embeddings are inconclusive, and further investigation is needed to clarify the effects of phonological interference on one level of embeddings. As suggested by Nakayama et al., it is possible that the effects of phonological interference are dependent on the level of embeddings in that more complex structures such as doubly center-embeddings might be obscuring any effects of phonological interference. For more conclusive remarks on this, other studies investigating the effect of phonological interference on doubly (or more complex) center-embedded structures are needed. Alternatively, the lack of phonological interference effects could be obscured by syntactic interference. In the present study, although it was possible to control for phonological interference while manipulating syntactic interference, it was not possible to control for syntactic interference while manipulating phonological interference. A future study with such a design could be more conclusive on the effects of phonological interference in center-embeddings. Lastly, the null results for the effect of phonological interference may be attributable to the fact that phonological similarity may not induce interference effects at all (e.g., Lewis, 1996; see similar Obata et al., 2010 for similar results on English).

The results of Experiment 3 for syntactic interference effects also showed that the unpredicted data pattern in Experiment 1 was due either to Experiment 1 being off-line or to the factive alternant verbs in the experimental stimuli in Experiment 1. A follow-up experiment using the same method in Experiment 1 with experimental stimuli excluding factive alternant verbs is being designed to tease apart these two possibilities.

The results also showed in the critical region significant effects of optimal phrasing of the sentence as NP1 || NP6 || VP1 that was induced by optimal and relatively balanced phrase lengths. The participants read the region faster and regressed less out of it when the phrase lengths encouraged an optimal phrasing of the structure as NP1 || NP6 || VP1. These effects were observed both in early (first fixation duration) and later stages of processing (regression path duration, rereading duration, total duration and probability of regression out). Unlike syntactic interference effects, phrase lengths effects were also observed in the spill-over region, but only in the later stages of processing such as regression path duration. Recall that the phrase lengths account of center-embedding difficulty predicts an enhanced processability when the 2-CE-RC structures are encouraged to optimally phrased by manipulating the lengths of the contributing phrases (Fodor, 2013). The findings of Experiment 3, which is, to my knowledge, the first study to investigate the time-course effects of phrase lengths in processing center-embedded structures, presented evidence that phrase lengths take effect in early stages of processing and persist to later stages. These findings are in line with the findings of Nickel and Fodor's (Nickel & Fodor, 2011; Fodor et al., 2017), and extend the generalizability of the phrase lengths account of center-embedding difficulty to real-time processing and Turkish, a structurally different language from English.

The results of Experiment 3 also indicated that both syntactic interference and phrase lengths effects were mainly observed in the critical region (with the exception of phrase lengths effects in the spill-over region for regression path duration), and during both early and later stages of processing. This suggests that both factors influence processing at about the same time in the sentence. But while syntactic interference effects do not linger, phrase length effects persist for later

regions, i.e., the spill-over region. This could be because unlike retrieval interference effects which are predicted to be observed upon processing syntactic heads, e.g., verbs in the present study, the integration of prosodic phrase length information into the current structure may take longer as it requires the processing of a whole prosodic phrase rather than a single word. This may support the earlier predictions which suggest that prosodic information may contribute to the reanalysis of previous syntactic processing (Pynte & Prieur, 1996) or the processing of immediate levels of phrasing may take longer (Marcus & Hindle, 1990).

The lingering effect of prosodic phrase lengths could also indicate that although both forces interacted in on-line processing of the structure, the final interpretations may be affected (more) by phrase lengths. The present study did not test that. To do so, an on-line task investigating both syntactic interference and prosodic phrase length effects with an end-of-sentence judgment task or an off-line experiment examining these two factors in a single design would be necessary.

Overall, the results of Experiment 3 demonstrated that syntactic dissimilarity manipulated with case marking on the subjects and phrase lengths that encourage the optimal phrasing of Turkish center-embeddings as NP1 || NP6 || VP1 eased the processing of Turkish center-embeddings in real-time processing and both factors took effect mainly in the critical region, i.e., VP1, during both early and later stages of processing.

CHAPTER 4

GENERAL DISCUSSION AND CONCLUSION

4.1 Summary of the findings and general discussion

This study investigated if the processing difficulty associated with Turkish center-embeddings could be modulated by similarity-based interference, more specifically syntactic and phonological interference that is manipulated through case marking, and/or prosodic phrasing that is manipulated through phrase lengths. It also examined if there was a missing-VP2 illusion in Turkish center-embeddings, and if syntactic interference and/or prosodic phrase lengths could modulate the potential existence of the illusion. Two end-of-sentence acceptability judgment tasks (Experiments 1 and 2) and one eye-tracking study (Experiment 3) were conducted to test these questions.

Experiment 1 examined whether or not syntactic interference, manipulated through case markings on the subject NPs, modulated the perceived difficulty of Turkish center-embeddings. It also investigated whether or not a missing-VP2 illusion existed in Turkish center-embeddings, and whether or not the existence of missing-VP2 illusion was affected by syntactic interference. Experiment 1 (and also Experiments 2 and 3) employed Turkish doubly center-embedded structures with relative clauses (2-CE-RCs) that were nested inside a matrix clause as a complement clause. An example sentence is: *[$_{NP1}$ Marangozların [$_{NP2}$ nakliyecilerin [$_{NP3}$ kiracının gri $_{NP4}$ koltuğu $_{VP3}$ yerleştirdiği odaya] $_{VP2}$ taşıdıkları dolabı] $_{VP1}$ kurduklarını] biliyorum. (I know that the carpenters built the closet that the movers moved to the room where the tenant placed the gray sofa.).* The experimental sentences were manipulated for grammaticality (grammatical with all three VPs present vs.

ungrammatical due to a missing VP2) and syntactic interference among the subject NPs (high vs. low syntactic interference). In the high syntactic interference conditions all three subject NPs, namely NP1, NP2 and NP3, were marked with the genitive case, *-(n)In*. In the low syntactic interference conditions, the first subject NP, namely NP1, was marked with the (null) nominative case, decreasing the number of genitive-case-marked subject NPs from three to two. In these conditions the first object NP, NP4, was also marked with the genitive case to control for phonological case repetition across the two conditions. The participants' task was to rate the acceptability of the sentences on a scale of 1 to 5 (5, the most acceptable). The literature on similarity-based interference predicted that in the case of decreased syntactic interference, i.e., low syntactic interference, processing Turkish center-embeddings would be easier (e.g., Lewis, 1996; 1998; 2000; Lewis & Vasishth, 2005; Lewis et al., 2006), and there would be no (or less prominent) missing-VP2 illusion (e.g., Bader, 2015; Häussler & Bader, 2015). The resource-based account predicted an illusion in Turkish center-embeddings as the illusion is considered to be cross-linguistic in that account (Gibson & Thomas, 1999), but the experience-based accounts predicted a lack of illusion, due to Turkish being head-final (Frank & Ernst, 2018; Frank et al., 2016; Vasishth et al., 2010).

The results of Experiment 1 showed that Turkish center-embeddings with high syntactic interference were regarded as more acceptable than those with low syntactic interference, which was the opposite of the predictions of the similarity-based interference account. This unexpected pattern of results was attributed to (i) the off-line methodology of the task (off-line data may have only revealed limited effects of case interference) and/or (ii) the inclusion of factive alternating verbs in the experimental sentences (the non-factive reading that is induced by the use of

factive alternating verbs and the subordinator *diye* in the low syntactic interference conditions may have added extra processing difficulty to the sentences, obscuring the effects of case interference). Although it is a possibility that the off-line methodology of Experiment 1 may not have revealed interference effects, the fact that the pattern of results was the opposite of the predictions makes it more likely that the unpredicted findings were due to the use of factive alternating verbs. In Experiment 3, an on-line method (eye-tracking) was employed with experimental sentences that excluded factive alternating verbs from the experimental stimuli (see below for details).

The results of Experiment 1 also showed mixed results for the grammaticality/missing-VP2 illusion in Turkish center-embeddings. While the grammatical sentences overall received higher ratings than those with a missing VP2, suggesting no illusion; follow-up analyses showed a missing-VP2 illusion in the sentences with low syntactic interference (equal ratings for the grammatical and ungrammatical sentences), but no illusion in those with high syntactic interference (higher ratings for the grammatical sentences than the ungrammatical sentences). These results suggest that missing-VP2 illusion may indeed be cross-linguistic, supporting the predictions of the resource-based account (Gibson & Thomas, 1999), and the illusion may be modulated by the perceived difficulty of the sentence.

Experiment 2 investigated whether or not the perceived difficulty of Turkish center-embeddings was modulated by prosodic phrasing that is induced by phrase lengths. It also examined whether or not the missing-VP2 illusion existed in Turkish center-embeddings, and whether or not its existence was affected by prosodic phrase lengths. The experimental sentences were manipulated for grammaticality as in Experiment 1 (grammatical with all three VPs present vs. ungrammatical due to a

missing VP2) and prosodic phrase lengths (encouraging vs. discouraging the optimal phrasing of the sentence). The optimal prosodic phrasing for Turkish center-embeddings was predicted to be NP1 || NP6 || VP1. An example sentence showing the prosodic phrases is (|| indicates expected prosodic boundaries): *[$_{NP1}$ Marangozların || [$_{NP6}$ nakliyecilerin kiracının gri koltuğu yerleştirdiği odaya taşıdıkları dolabı] || $_{VP1}$ kurduklarını] biliyorum. (I know that the carpenters built the closet that the movers moved to the room where the tenant placed the gray sofa.).* In the encouraging phrase lengths conditions NP1 and VP1 were lengthened with two additional prosodic words (PWds) to have optimal and relatively balanced phrase lengths in the sentences. In the discouraging phrase lengths conditions NP6 was lengthened with four additional PWds to discourage the optimal and balanced phrasing of the sentences. As in Experiment 1, the participants' task was to rate the acceptability of the sentences on a scale of 1 to 5 (5, the most acceptable). The literature on prosodic phrase lengths predicts that when center-embeddings were encouraged to be optimally phrased as NP1 || NP6 || VP1, they would be easier to process, and there would be no missing-VP2 illusion (Fodor, 2013). The predictions regarding the overall existence of missing-VP2 illusion were the same as in Experiment 1.

The results of Experiment 2 demonstrated that Turkish center-embeddings with phrase lengths that encouraged the optimal phrasing of the sentence as NP1 || NP6 || VP1 were perceived to be more acceptable than those with phrase lengths discouraging the optimal phrasing. These findings are in line with earlier studies on English (Nickel & Fodor, 2011; Fodor et al., 2017), and they confirm and extend Fodor's (2013) predictions for the role of phrase lengths on processing of center-embedded sentences to Turkish, a language typologically different from English.

Moreover, as in Experiment 1, the results showed an overall higher acceptability for the grammatical sentences than the ungrammatical sentences, suggesting that overall there was no missing-VP2 illusion in Turkish center-embeddings. However, further analyses demonstrated that the existence of illusion was modulated by prosodic phrase lengths. That is, whereas there was a missing-VP2 illusion in the sentences with discouraging phrase lengths (equal ratings for the grammatical and ungrammatical sentences), there was no illusion in those with encouraging phrase lengths (higher ratings for the grammatical sentences than the ungrammatical ones). These findings are similar to those in Experiment 1 in that missing-VP2 illusion is cross-linguistic (Gibson & Thomas, 1999), and they indicate that the illusion may be modulated by prosodic phrase lengths (Fodor, 2013). One thing to note that in both Experiment 1 and Experiment 2, overall the grammatical sentences were rated higher than ungrammatical sentences. In the conditions where processing the structure is predicted to be difficult (e.g., the discouraging phrase lengths in Experiment 2), the illusion appeared, but it was not too strong. That is, the ratings for the grammatical sentences were similar to those for ungrammatical sentences, i.e., the grammatical sentences did not receive higher ratings than the ungrammatical sentences (see Gibson & Thomas, 1999 Huang & Phillips, 2020 for similar results from English). Thus, although the perceived difficulty of the sentences modulated the existence of illusion in Turkish, a verb-final language; it was not to the extent that grammatical sentences would be perceived as more acceptable than their ungrammatical versions as in the case of verb-initial languages such as English (e.g., Christiansen & MacDonald, 2009) or French (Gimenes et al., 2009).

Overall, the results of Experiment 1 and 2 showed that the existence of missing-VP2 illusion was modulated by the perceived difficulty of the sentence: the

more difficult the sentence was, the more likely it was for the illusion to appear. These results suggest that the illusion may be language-independent as predicted by the resource-based account (Gibson & Thomas, 1999). These results are in line with Dokudan et al.'s (2017) findings on Turkish center-embeddings with sentential complements showing evidence for the presence of illusion. Moreover, these results are similar to the earlier findings on German which provided evidence that the existence of illusion was dependent on other factors such as the clause type of the final verb in the sentence (Bader, 2015; Häussler & Bader, 2015). The lack of an overall illusion (overall higher ratings for the grammatical sentences than the ungrammatical sentences), on the other hand, is similar to the earlier findings showing an absence of missing-VP2 illusion on verb-final languages such as German (Vasishth et al., 2010), Dutch (Frank & Ernst, 2018; Frank et al., 2016) and Hindi (Husain & Bhatia, 2018). It is, thus, possible that verb-finality also played a role in the missing-VP illusion, as predicted by the experience-based accounts, by limiting the presence of illusion to the conditions which were perceived to be more difficult. Further studies investigating the effects of other factors on missing-VP2 illusion in other verb-final languages are needed for more conclusive remarks.

To investigate the time-course of interference and prosodic phrase lengths effects, Experiment 3, an eye-tracking experiment, was conducted. Experiment 3 investigated the effects of interference and prosodic phrase lengths in a single design, which allowed to test whether one of these factors would precede the other or both effects would be observed at about the same time and interact. The experimental sentences were manipulated for interference (high syntactic – high phonological, low syntactic – high phonological or low syntactic – low phonological) and prosodic phrase lengths as in Experiment 2 (encouraging vs. discouraging the optimal

phrasing of the sentence as NP1 || NP6 || VP1). Note that in addition to the syntactic interference manipulation as in Experiment 1, a third condition with low syntactic – low phonological interference was also added in Experiment 3. This was done to investigate phonological interference effects. In the low syntactic – low phonological conditions, the first object NP was marked with the accusative case, decreasing the number of genitive-case-marked NPs from three to two. The factive alternant verbs were not used in Experiment 3 to eliminate the non-factive reading in the low syntactic interference conditions. The participants' eye-movements were examined for both the critical region, i.e., the final verb in the 2-CE-RC structure, and the spill-over region, i.e., the matrix verb following the critical region. The predictions of the similarity-based interference for syntactic interference and prosodic phrase lengths accounts were the same as in Experiments 1 and 2, respectively. Additionally, an ease of processing with decreased phonological interference was predicted.

The data for Experiment 3 demonstrated for the critical region that the participants spent more time in reading this region or were more likely to regress out of it when the sentence had high syntactic interference than when it had low syntactic interference. This was the case regardless of the phonological interference. The effects of syntactic interference were evident in both early measures of eye-tracking such as gaze duration and later measures such as regression path duration, rereading duration, total duration and probability of regression out. Thus, unlike the results of Experiment 1, the results of Experiment 3 provided evidence that decreasing syntactic similarity increased the processability of Turkish embeddings as predicted by the similarity-based interference accounts (Lewis, 1996; 1998; 2000; Lewis & Vasishth, 2005; Lewis et al., 2006), and they pattern with the earlier findings on processing center-embedded structures (Lewis & Nakayama, 1999; 2002; Uehara &

Bradley, 1996; Uehara, 2003 for Japanese). The difference between the findings of Experiment 1 and Experiment 3 regarding syntactic interference were attributed to the use of an on-line methodology and to the exclusion of factive alternating verbs in Experiment 3. But, as mentioned above, the off-line methodology explanation would not account for the revised pattern of results in Experiment 1; thus, the use of factive alternating verbs may be more likely to explain the findings there. To test this possibility, a follow-up off-line acceptability judgment task with stimuli excluding factive alternating verbs is under way.

The reading time data showed no reliable difference between the high and low phonological interference conditions. This was the case both at the critical region and the spill-over region. The null effect of phonological interference was in line with Uehara and Bradley's (1996) findings for Korean, but it contradicted with the findings for Hindi in Vasishth's (2003) and for Korean in Nakayama et al.'s (2005) studies. Three possibilities might be suggested to explain the null results regarding phonological interference effects: (i) the complexity of experimental stimuli, (Experiment 3 employed doubly center-embedded structures nested as a complement clause inside a matrix clause as opposed to the singly-embedded sentences in the studies on Hindi (Vasishth, 2003) and Korean (Nakayama et al., 2005)), (ii) the lack of conditions in Experiment 3 that controlled for syntactic interference while manipulating phonological interference or (iii) the absence of phonological interference effects in similarity-based retrieval interference (e.g., Obata et al., 2010). For more conclusive remarks on the role of phonological interference on center-embedding difficulty, future studies are needed.

The results of Experiment 3 also revealed for both the critical region and the spill-over region that there was a significant slow-down in reading and an increased

probability of regression out of the region in the sentences with phrase lengths that discouraged the optimal phrasing of Turkish center-embeddings compared to those with phrase lengths that encouraged the optimal phrasing. This difference was evident for the critical region in both early (in first fixation duration) and later measures (in regression path duration, rereading duration, total duration and probability of regression out), and for the spill-over region in later measures (in regression path duration). These results confirm Fodor's (2013) prediction, with on-line data, that when optimally phrased center-embedded structures are easier to process. But the more important contribution of Experiment 3 to the literature is that phrase lengths effects take place immediately, at the critical region.

It is also important to note that syntactic interference effects were observed only in the critical region, but the effects of prosodic phrase lengths extended to the spill-over region. It is possible that unlike interference effects which were observed upon processing syntactic heads, i.e., verbs, the integration of phrase lengths may have taken longer because it requires the processing of a whole prosodic phrase. This finding is in line with earlier predictions suggesting that prosodic information may be used during reanalysis (Marcus & Hindle, 1990) or that the immediate levels of phrasing may take effect later (Pynte & Prieur, 1996). Further studies are needed to investigate the time-course of prosodic phrase lengths effects.

It is also possible that although both interference and phrase lengths effects affected the on-line processing of Turkish center-embeddings, the final interpretations of the sentences may have been affected more by phrase lengths than by interference effects. To investigate this possibility, an on-line task investigating both syntactic interference and prosodic phrase length effects with an end-of-

sentence judgment task or an off-line experiment examining these two factors in a single design would be necessary.

The data in Experiment 3 also showed an interaction between syntactic interference and prosodic phrase lengths. This was evident in later measures such as regression path duration, rereading duration and total duration. The follow-up pairwise comparisons indicated that the sentences with high syntactic interference and discouraging phrase lengths had the longest reading time, and those with low syntactic interference and encouraging phrase lengths had the shortest reading time. This finding is in line with the predictions of both similarity-based interference and prosodic phrase lengths accounts, and it suggests that both factors influence the processing of center-embedded structures in Turkish at about the same time in the sentence, i.e., at the critical region, and during similar stages of processing, i.e., in later measures.

Overall, the results of Experiment 3 showed a facilitative role of decreased syntactic case interference, but not decreased phonological case interference, in processing doubly center-embedded structures in Turkish (e.g., Lewis & Vasishth, 2005; Lewis et al., 2006). The results also showed that when Turkish center-embeddings had optimal and relatively balanced phrase lengths, their processing was facilitated. The Turkish data on phrase lengths extended the predictions of prosodic phrase lengths account (Fodor, 2013) to a non-English language and showed, for the first time, that phrase lengths effects took place immediately and contributed to the real-time processing of the construction.

4.2 Conclusion

The end-of-sentence acceptability judgment tasks provided evidence that prosodic phrase lengths modulated the perceived difficulty of Turkish center-embeddings, and missing-VP2 illusion existed in Turkish but only in the relatively more difficult center-embedded sentences (e.g., sentences with phrase lengths that discouraged optimal phrasing of the structure). The findings in the eye-tracking experiment indicated a role for both syntactic interference and optimal phrase lengths in processing Turkish center-embedded sentences. The present study is the first to investigate these two factors in a single design, and the data are in the direction that confirms the predicted effects of both factors: when syntactic interference was decreased and the phrase lengths encouraged the optimal phrasing, sentences were the easiest to process, but when syntactic interference was increased and the phrase lengths discouraged the optimal phrasing, the sentences were the most difficult to process. The findings of the present study also extend, for the first time, the predictions of prosodic phrase lengths to a non-English language and report that phrase lengths effects took place immediately.

4.3 Limitations and future work

This thesis presented the first empirical evidence, to my knowledge, for the role of similarity-based interference and prosodic phrase lengths in processing Turkish center-embedded structures. Also, it was the first study that employed Turkish center-embedded structures with relative clauses as the experimental stimuli. This study contributed to the relatively scarce sentence processing literature on Turkish and to the cross-linguistic literature on center-embedding difficulty by confirming

the predictions of the resource-based, similarity-based interference and prosodic phrase lengths accounts.

There were some limitations of the study. One concerns the pattern of results for syntactic interference in Experiment 1. The data in Experiment 1 showed, contra the predictions of similarity-based interference account for a facilitative role for syntactic similarity. This was attributed either to the use of an off-line measure or to the use of factive alternating verbs in the experimental stimuli. Another off-line acceptability judgment experiment not employing factive alternating verbs has been designed to tease apart these two possibilities, its data collection is under way.

Experiment 3 did not show any evidence for phonological interference effects. This could be a genuine effect in that phonological features do not cause interference effects (e.g., Lewis, 1996; Obata et al., 2010). Alternatively, it could be due to the complexity of the experimental items and/or the lack of conditions that controlled for syntactic interference while manipulating phonological interference. An experiment investigating phonological interference effects with less complex experimental stimuli or with manipulations of phonological interference while controlling for syntactic interference would help us better understand whether phonological interference has a role in the processing difficulty of Turkish center-embeddings.

Experiment 3 also revealed that unlike syntactic interference effects, prosodic phrase length effects continued at the spill-over region, which may suggest a need for a longer time to integrate prosodic information into the structure. Most studies examining prosodic phrase lengths test these effects sentence-finally, presumably because that is when the parser has the full information regarding the overall phrase lengths in the sentence. But future studies employing eye-tracking methodology

could provide further information on the time-course of the use of prosody-induced phrase lengths information.

APPENDIX A

ETHICS COMMITTEE APPROVAL

T.C.
BOĞAZİÇİ ÜNİVERSİTESİ
Sosyal ve Beşeri Bilimler Yüksek Lisans ve Doktora Tezleri Etik İnceleme Komisyonu

Sayı: 2019 - 69 20 Kasım 2019

Özge Bakay
Yabancı Diller Eğitimi

Sayın Araştırmacı,

"Türkçede İç İçe Yerleşik Cümle Yapılarının İşlemlenmesi" başlıklı projeniz ile ilgili olarak yaptığınız SBB-EAK 2019/67 sayılı başvuru komisyonumuz tarafından 20 Kasım 2019 tarihli toplantıda incelenmiş ve uygun bulunmuştur.

Prof. Dr. Feyza Çorapçı

Doç. Dr. Mehmet Yiğit Gürdal

Doç. Dr. Ebru Kaya

Dr. Öğr. Üyesi İnci Ayhan

APPENDIX B

BACKGROUND QUESTIONNAIRE

Bu ankette vereceğiniz bilgiler kesinlikle gizli tutulacaktır. Lütfen uygun şıkkı işaretleyerek ya da boşlukları doldurarak tamamlayınız.

(The information you will provide on this questionnaire will be kept strictly confidential. Please circle or fill in information as appropriate.)

Demografik Bilgi (demographic info): Bu bölümdeki sorular sizin hakkınızda genel bilgi edinme amaçlıdır. (The questions in this section ask you to provide information about yourself in general.)

1. Yaşınız (age): _____

2. Doğum yeriniz (place of birth): _____

3. Cinsiyetiniz (gender): _____

4. Mesleğiniz (occupation): _____

5. En son aldığınız eğitim seviyesi nedir? (What is the highest degree you earned?

a) İlköğretim (elementary school) b) Ortaokul (secondary school)

c) Lise (high school) d) Yüksekokul (two-year college)

d) Üniversite (four-year college) e) Yüksek lisans (master's)

f) Doktora (PhD)

6. Herhangi bir işitme probleminiz var mı? (Do you have any hearing problem?)

a) Evet (Yes) b) Hayır (No)

7. Cevabınız 'evet'se sorunu nasıl gideriyorsunuz? (If yes, how do you correct it?)

a) İşitme cihazı kullanıyorum. (I use hearing aid.)

b) Diğer (Lütfen belirtiniz) (Other (Please specify)): _____

8. Görme probleminiz var mı? (Do you have any visual problem?)

a) Evet (Yes) b) Hayır (No)

9. Cevabınız 'evet'se sorunu nasıl gideriyorsunuz? (If yes, how do you correct it?)

a) Gözlük kullanıyorum. (I use glasses.)

b) Kontakt lens kullanıyorum. (I use contact lenses.)

c) Diğer (Lütfen belirtiniz) (Other (Please specify)):_____

10. Sağ elinizi mi sol elinizi mi daha sık kullanıyorsunuz? (Are you right-handed or left-handed?)

a) Sağ (Right-handed) b) Sol (Left-handed)

Dil Geçmişi (Language Background): Anketin bu bölümü dil geçmişinizi ve dil ile ilgili aktiviteleriniz üzerine sorular içermektedir. (This section of the questionnaire aims to elicit information about your language background and language-related activities.)

1. Türkçe anadiliniz mi? (Is Turkish your native language?)

a) Evet (Yes) b) Hayır (No)

2. Cevabınız 'hayır'sa anadiliniz nedir? Lütfen belirtiniz (If no, what is your native language? Please specify): _____

3. Anadilinizden başka bir dil konuşuyor musunuz? (Do you speak an languages other than your native language?)

a) Evet (Yes) b) Hayır (No)

4. Cevabınız 'evet'se lütfen dil(ler)deki yeterliliğinizi 1'in zayıf, 5'in mükemmel olduğu, 1-5 arası ölçekte belirtiniz (If yess, how would you rate your linguistic ability in that language(s) in the following areas?):

Dil (Language)	Okuma (Reading)	Dinleme (Listening)	Yazma (Writing)	Konuşma (Speaking)

5. Eğitiminizi hangi dilde aldınız? (What was the main medium of instruction language for your education?)

İlköğretim (Elementary school):

a) Türkçe (Turkish) b) Diğer (lütfen belirtiniz) (Other (please specify)): _____

Ortaokul (Secondary school):

a) Türkçe (Turkish) b) Diğer (lütfen belirtiniz) (Other (please specify)): _____

Lise (High school):

a) Türkçe (Turkish) b) Diğer (lütfen belirtiniz) (Other (please specify)): _____

Üniversite (University:

a) Türkçe (Turkish) b) Diğer (lütfen belirtiniz) (Other (please specify)): _____

Lisansüstü (Master's and above):

a) Türkçe (Turkish) b) Diğer (lütfen belirtiniz) (Other (please specify)): _____

6. Türkçe'nin anadil olmadığı herhangi bir ülkede yaşadınız mı? (Have you ever lived in a non-Turkish-speaking country?)

a) Evet (Yes) b) Hayır (No)

7. Cevabınız 'evet'se, nerede ve ne kadar kaldınız? (If yes, where and how long did you live?) _____

8. Haftada ne kadar Türkçe okuma yapıyorsunuz?

(How much time do you spend reading in Turkish per week?)

a) 5 saatten az (less than 5 hrs) b) 5-10 saat (5-10 hrs)

c) 10-15 saat (10-15 hrs) d)15 saatten fazla (more than 15 hrs)

9. Haftada kaç saat Türkçe (müzik, radyo vs.) dinliyorsunuz?

(How much time do you spend listening in Turkish (music, radio etc.) per week?)

a) 5 saatten az (less than 5 hrs) b) 5-10 saat (5-10 hrs)

c) 10-15 saat (10-15 hrs) d)15 saatten fazla (more than 15 hrs)

10. Haftada kaç saat Türkçe televizyon seyrediyorsunuz?

(How much time do you spend watching TV in Turkish per week?)

a) 5 saatten az (less than 5 hrs) b) 5-10 saat (5-10 hrs)

c) 10-15 saat (10-15 hrs) d)15 saatten fazla (more than 15 hrs)

Teşekkürler! (Thank you!)

APPENDIX C

EXPERIMENT 1: EXPERIMENTAL ITEMS

AND COMPREHENSION STATEMENTS

1.

a. **HighInt, Gra/Ungra:** Garsonlar**ın**[17] müşteriler**in** işletmeci**nin** yeni restorana koyduğu kutuya bıraktıkları/ ~~bıraktıkları~~[18] *yüklü*[19] bahşişi topladıklarını (şimdi)[20] gördüm.

b. **LowInt, Gra/Ungra:** Garsonlar müşteriler**in** işletmeci**nin** rezidansın restoranına koyduğu kutuya bıraktıkları/ ~~bıraktıkları~~ *yüklü* bahşişi topladılar diye gördüm.
'I (just) saw that the waiters collected the *loaded* tips that the customers left/ ~~left~~ in the box that the manager put in the new restaurant/ residence's restaurant.'

NP1-VP1 :Garsonlar bahşişi topladı.
NP1- VP3 :Garsonlar kutuyu koydu.
NP3-VP1 :İşletmeci bahşişi topladı.
NP3-VP3 :İşletmeci kutuyu koydu.

2.

a. **HighInt, Gra/Ungra:** Marangozlar**ın** nakliyeciler**in** kiracı**nın** gri koltuğu yerleştirdiği odaya taşıdıkları/ ~~taşıdıkları~~ *ahşap* dolabı kurduklarını (dün) gördüm.

b. **LowInt, Gra/Ungra:** Marangozlar nakliyeciler**in** kiracı**nın** koltuğun minderlerini yerleştirdiği odaya taşıdıkları/ ~~taşıdıkları~~ *ahşap* dolabı kurdular diye gördüm.
'I (yesterday) saw that the carpenters built the *wooden* closet that the movers moved/ ~~moved~~ to the room that the tenant placed the gray sofa/ sofa's cushions in.'

NP1-VP1 :Marangozlar dolabı kurdu.
NP1- VP3 :Marangozlar koltuğu yerleştirdi.
NP3-VP1 :Kiracı dolabı kurdu.
NP3-VP3 :Kiracı koltuğu yerleştirdi.

3.

a. **HighInt, Gra/Ungra:** Çırakları**n** boyacıları**n** satıcı**nın** yeni müdüre gösterdiği mobilyaya sürdükleri/ ~~sürdükleri~~ *yağlı* boyayı döktüklerine (çok) üzüldüm.

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[17] Genitive case manipulating syntactic interference on the subjects is given in bold.
[18] The verbs that are strikethrough are omitted in the ungrammatical conditions.
[19] Italic words are added in place of omitted verbs in the ungrammatical conditions.
[20] Words in parentheses are added in the High Syntactic Interference conditions in place of the complementizer in the Low Syntactic Interference conditions.

b. **LowInt, Gra/Ungra:** Çıraklar boyacıları**n** satıcı**nın** mağazanın müdürüne gösterdiği mobilyaya sürdükleri/ ~~sürdükleri~~ *yağlı* boyayı döktüler diye üzüldüm.
'I felt (so) sorry that the apprentices spilled the *oil* paint that the painters applied/ ~~applied~~ to the furniture that the salesperson showed to the new manager/ store's manager.'

NP1-VP1 :Çıraklar boyayı döktü.
NP1- VP3 :Çıraklar mobilyayı gösterdi.
NP3-VP1 :Satıcı boyayı döktü.
NP3-VP3 :Satıcı mobilyayı gösterdi.

4.

a. **HighInt, Gra/Ungra:** Velileri**n** öğretmenleri**n** matematikçi**nin** üst kurula gönderdiği öğrenciye verdikleri/ ~~verdikleri~~ *ağır* cezayı hatırlattıklarını (yeni) anladım.
b. **LowInt, Gra/Ungra:** Veliler öğretmenleri**n** matematikçi**nin** okulun kuruluna gönderdiği öğrenciye verdikleri/ ~~verdikleri~~ *ağır* cezayı hatırlattılar diye anladım.
'I (just) understood that the parents reminded the *severe* punishment that the teachers gave/ ~~gave~~ to the student that the math teacher sent to the supreme board/ school's board.'

NP1-VP1 :Veliler cezayı hatırlattı.
NP1- VP3 :Veliler öğrenciyi gönderdi.
NP3-VP1 :Matematikçi cezayı hatırlattı.
NP3-VP3 :Matematikçi öğrenciyi gönderdi.

5.

a. **HighInt, Gra/Ungra:** Hırsızları**n** yazılımcıları**n** müdür**ün** yeni ofise aldığı bilgisayara yükledikleri/ ~~yükledikleri~~ *büyük* dosyayı kopyaladıklarına (hâlâ) şaşırıyorum.
b. **LowInt, Gra/Ungra:** Hırsızlar yazılımcıları**n** müdür**ün** yönetimin ofisine aldığı bilgisayara yükledikleri/ ~~yükledikleri~~ *büyük* dosyayı kopyaladılar diye şaşırıyorum.
'I am (still) shocked that the thieves copied the *big* document that the software developers downloaded/ ~~downloaded~~ to the computer that the manager bought for the new office/ administration's office.'

NP1-VP1 :Hırsızlar dosyayı kopyaladı.
NP1- VP3 :Hırsızlar bilgisayar aldı.
NP3-VP1 :Müdür dosyayı kopyaladı.
NP3-VP3 :Müdür bilgisayar aldı.

6.

a. **HighInt, Gra/Ungra:** Eczacıları**n** doktorları**n** hemşire**nin** ilaçlı serumu taktığı hastaya yazdıkları/ ~~yazdıkları~~ *uzun* reçeteyi açıkladıklarını (şimdi) duydum.

b. **LowInt, Gra/Ungra:** Eczacılar doktorlar**ın** hemşire**nin** hastanenin serumunu taktığı hastaya yazdıkları/ ~~yazdıkları~~ *uzun* reçeteyi açıkladılar diye duydum.
'I (just) heard that the pharmacists explained the *long* prescription that the doctors wrote/ ~~wrote~~ to the patient that the nurse put the medicated IV/ hospital's IV on.'

NP1-VP1 :Eczacılar reçeteyi açıkladı.
NP1- VP3 :Eczacılar serumu taktı.
NP3-VP1 :Hemşireler reçeteyi açıkladı.
NP3-VP3 :Hemşireler serumu taktı.

7.

a. **HighInt, Gra/Ungra:** Hemşireler**in** doktorlar**ın** hasta**nın** genç eczacıya gösterdiği yaraya önerdikleri/ ~~önerdikleri~~ *koruyucu* merhemi sürdüklerine (çok) sevindim.
b. **LowInt, Gra/Ungra:** Hemşireler doktorlar**ın** hasta**nın** hastanenin eczacısına gösterdiği yaraya önerdikleri/ ~~önerdikleri~~ *koruyucu* merhemi sürdüler diye sevindim.
'I became (so) happy that the nurses applied the *protective* salve that the doctors recommended/ ~~recommended~~ for the scar that the patient showed to the young pharmacist/ hospital's pharmacist.'

NP1-VP1 :Hemşireler merhemi sürdü.
NP1- VP3 :Hemşireler yarayı gösterdi.
NP3-VP1 :Hasta merhemi sürdü.
NP3-VP3 :Hasta yarayı gösterdi.

8.

a. **HighInt, Gra/Ungra:** Asistanlar**ın** editörler**in** edebiyatçı**nın** ilgili okuyuculara önerdiği siteye yazdıkları/ ~~yazdıkları~~ *detaylı* makaleyi yüklediklerine (çok) sevindim.
b. **LowInt, Gra/Ungra:** Asistanlar editörler**in** edebiyatçı**nın** derginin okuyucularına önerdiği siteye yazdıkları/ ~~yazdıkları~~ *detaylı* makaleyi yüklediler diye sevindim.
'I was (so) happy that the assistants uploaded the *detailed* article that the editors wrote/ ~~wrote~~ for the website that the men of letters recommended to the interested readers/ magazine's readers.'

NP1-VP1 :Asistanlar makalayi yükledi.
NP1- VP3 :Asistanlar siteyi önerdi.
NP3-VP1 :Edebiyatçı makaleyi yükledi.
NP3-VP3 :Edebiyatçı siteyi önerdi.

9.

a. **HighInt, Gra/Ungra:** Terziler**in** modacılar**ın** menajer**in** hevesli yapımcıya tanıttığı mankene tasarladıkları/ ~~tasarladıkları~~ *gösterişli* elbiseyi diktiklerini (net) hatırlıyorum.
b. **LowInt, Gra/Ungra:** Terziler modacılar**ın** menajer**in** filmin yapımcısına tanıttığı mankene tasarladıkları/ ~~tasarladıkları~~ *gösterişli* elbiseyi diktiler diye hatırlıyorum.

'I (clearly) remember that the tailors sewed the *ostentatious* dress that the stylists designed/ ~~designed~~ for the model that the manager introduced to the enthusiastic producer/ movie's producer.'

NP1-VP1 :Terziler elbiseyi dikti.
NP1- VP3 :Terziler mankeni tanıttı.
NP3-VP1 :Menajer elbiseyi dikti.
NP3-VP3 :Menajger mankeni tanıttı.

10.

a. **HighInt, Gra/Ungra:** Eleştirmenler**in** kameramanları**n** yapımcı**nın** yeni çekimlere çağırdığı yönetmene hazırladıkları/ ~~hazırladıkları~~ *tanıtıcı* klibi yorumladıklarını (dergide) okudum.
b. **LowInt, Gra/Ungra:** Eleştirmenler kameramanları**n** yapımcı**nın** dizinin çekimlerine çağırdığı yönetmene hazırladıkları/ ~~hazırladıkları~~ *tanıtıcı* klibi yorumladılar diye okudum.
'I read (on the magazine) that the critics reviewed the *introductory* video that the cameramen prepared/ ~~prepared~~ for the director that the producer invited to the new shot/ series' shot.'

NP1-VP1 :Eleştirmenler klibi yorumladı.
NP1- VP3 :Eleştirmenler yönetmeni çağırdı.
NP3-VP1 :Yapımcı klibi yorumladı.
NP3-VP3 :Yapımcı yönetmeni çağırdı.

11.

a. **HighInt, Gra/Ungra:** Savcıları**n** avukatları**n** muhasebeci**nin** yeni belgeleri sunduğu hakime savundukları/ ~~savundukları~~ *büyük* yolsuzluğu açıkladıklarını (iyi) biliyorum.
b. **LowInt, Gra/Ungra:** Savcılar avukatları**n** muhasebeci**nin** sözleşmenin belgelerini sunduğu hakime savundukları/ ~~savundukları~~ *büyük* yolsuzluğu açıkladılar diye biliyorum.
'I know (well) that the prosecutors declared the *big* corruption that the attorneys defended/ ~~defended~~ to the judge that the accountant presented the new documents/ contract's documents to.'

NP1-VP1 :Savcılar yolsuzluğu açıkladı.
NP1- VP3 :Savcılar belgeleri sundu.
NP3-VP1 :Muhasebeci yolsuzluğu açıkladı.
NP3-VP3 :Muhasebeci belgeleri sundu.

12.

a. **HighInt, Gra/Ungra:** Hostesler**in** güvenlikler**in** pilot**un** sağ çıkışa yönlendirdiği yolcuya yaptıkları/ ~~yaptıkları~~ *sözlü* uyarıyı tekrarladıklarını (şimdi) duydum.
b. **LowInt, Gra/Ungra:** Hostesler güvenlikler**in** pilot**un** uçağın çıkışına yönlendirdiği yolcuya yaptıkları/ ~~yaptıkları~~ *sözlü* uyarıyı tekrarladılar diye duydum.

‘I (just) heard that the flight attendants repeated the *oral* warning that the security gave/ ~~gave~~ to the passenger that the pilot directed to the exit on the right/ plane’s exit.’

NP1-VP1 :Hostesler uyarıyı tekrarladı.
NP1- VP3 :Hostesler yolcuyu yönlendirdi.
NP3-VP1 :Pilot uyarıyı tekrarladı.
NP3-VP3 :Pilot yolcuyu yönlendirdi.

13.

a. **HighInt, Gra/Ungra:** Temizlikçiler**in** işletmeciler**in** şoför**ün** yeni servisi gösterdiği turiste ayırdıkları/ ~~ayırdıkları~~ *özel* odayı hazırladıklarına (çok) sevindim.
b. **LowInt, Gra/Ungra:** Temizlikçiler işletmeciler**in** şoför**ün** otelin servisini gösterdiği turiste ayırdıkları/ ~~ayırdıkları~~ *özel* odayı hazırladılar diye sevindim.
‘I became (so) happy that the cleaners prepared the *private* room that the managers reserved/ ~~reserved~~ for the tourist that the driver showed the new shuttle/ hotel’s shuttle.’

NP1-VP1 :Temizlikçiler odayı hazırladı.
NP1- VP3 :Temizlikçiler servisi gösterdi.
NP3-VP1 :Şoför odayı hazırladı.
NP3-VP3 :Şoför servisi gösterdi.

14.

a. **HighInt, Gra/Ungra:** Yetkilileri**n** veterinerleri**n** köylü**nün** büyük barınağa getirdiği köpeğe yazdıkları/ ~~yazdıkları~~ *yeni* ilacı ısmarladıklarına (çok) sevindim.
b. **LowInt, Gra/Ungra:** Yetkililer veterinerleri**n** köylü**nün** ilçenin barınağına getirdiği köpeğe yazdıkları/ ~~yazdıkları~~ *yeni* ilacı ısmarladılar diye sevindim.
‘I became (so) happy that the officials ordered the *new* medicine that the vets prescribed/ ~~prescribed~~ for the dog that the villager brought to the big shelter/ district’s shelter.’

NP1-VP1 :Yetkililer ilacı ısmarladı.
NP1- VP3 :Yetkililer köpeği getirdi.
NP3-VP1 :Köylü ilacı ısmarladı.
NP3-VP3 :Köylü köpeği getirdi.

15.

a. **HighInt, Gra/Ungra:** Hizmetçiler**in** perdeciler**in** bakıcı**nın** demir başlığı taşıdığı odaya diktikleri/ ~~diktikleri~~ *ince* tülü astıklarını (dün) gördüm.
b. **LowInt, Gra/Ungra:** Hizmetçiler perdeciler**in** bakıcı**nın** karyolanın başlığını taşıdığı odaya diktikleri/ ~~diktikleri~~ *ince* tülü astılar diye gördüm.
‘I saw (yesterday) that the maids hung the *fine* tulle curtains that the curtain sellers sewed/ ~~sewed~~ for the room that the caretaker moved the iron headboard/ bed’s headboard.’

NP1-VP1 :Hizmetçiler tülü astı.
NP1- VP3 :Hizmetçiler başlığı taşıdı.
NP3-VP1 :Bakıcı tülü astı.
NP3-VP3 :Bakıcı başlığı taşıdı.

16.

a. **HighInt, Gra/Ungra:** Dilenciler**in** çocukları**n** çöpçü**nün** ön kapıya bıraktığı kutuya fırlattıkları/ ~~fırlattıkları~~ *eski* oyuncakları topladıklarını (iyi) hatırlıyorum.
b. **LowInt, Gra/Ungra:** Dilenciler çocukları**n** çöpçü**nün** kapının önüne bıraktığı kutuya fırlattıkları/ ~~fırlattıkları~~ *eski* oyuncakları topladılar diye hatırlıyorum.
'I remember (well) that the beggars collected the *old* toys that the kids threw/ ~~threw~~ into the box that the garbageman left at the frontdoor/ door's front.'

NP1-VP1 :Dilenciler oyuncakları topladı.
NP1- VP3 :Dilenciler kutuyu bıraktı.
NP3-VP1 :Çöpçü oyuncakları topladı.
NP3-VP3 :Çöpçü kutuyu bıraktı.

17.

a. **HighInt, Gra/Ungra:** Aranjörler**in** besteciler**in** organizatör**ün** dünkü toplantıya çağırdığı şarkıcıya verdikleri/ ~~verdikleri~~ *yeni* besteyi düzenlediklerini (yeni) duydum.
b. **LowInt, Gra/Ungra:** Aranjörler besteciler**in** organizatör**ün** şirketin toplantısına çağırdığı şarkıcıya verdikleri/ ~~verdikleri~~ *yeni* besteyi düzenlediler diye duydum.
'I (just) heard that the arrangers arranged the *new* composition that the composers gave/ ~~gave~~ to the singer that the promoter invited to the yesterday's meetings/ company's meeting.'

NP1-VP1 :Aranjörler besteyi düzenledi.
NP1- VP3 :Aranjörler şarkıcıyı çağırdı.
NP3-VP1 :Organizatör besteyi düzenledi.
NP3-VP3 :Organizatör şarkıcıyı çağırdı.

18.

a. **HighInt, Gra/Ungra:** Öğretmenler**in** sanatçıları**n** müdür**ün** diğer kuruma bildirdiği öğrencilere gönderdikleri/ ~~gönderdikleri~~ *küçük* hediyeleri paylaştırdıklarına (çok) sevindim.
b. **LowInt, Gra/Ungra:** Öğretmenler sanatçıları**n** müdür**ün** belediyenin kurumuna bildirdiği öğrencilere gönderdikleri/ ~~gönderdikleri~~ *küçük* hediyeleri paylaştırdılar diye sevindim.
'I became (so) happy that the teachers alloted the *small* presents that the artists sent/ ~~sent~~ to the students that the principal reported to the other organization/ municipality's organization.'

NP1-VP1 :Öğretmenler hediyeleri paylaştırdı.
NP1- VP3 :Öğretmenler öğrencileri bildirdi.
NP3-VP1 :Müdür hediyeleri paylaştırdı.
NP3-VP3 :Müdür öğrencileri bildirdi.

19.

a. **HighInt, Gra/Ungra:** Asistanların kimyagerlerin laborantın genç stajyere temizlettiği tüpe doldurdukları/ ~~doldurdukları~~ *beyaz* karışımı döktüklerini (yeni) duydum.
b. **LowInt, Gra/Ungra:** Asistanlar kimyagerlerin laborantın kliniğin stajyerine temizlettiği tüpe doldurudkları/ ~~doldurdukları~~ *beyaz* karışımı döktüler diye duydum.
'I (just) heard that the assistants spilled the *white* mixture that the chemists filled/ ~~filled~~ the tube that the laborant made the young intern/ clinic's intern clean.'

NP1-VP1 :Asistanlar karışımı döktü.
NP1- VP3 :Asistanlar tüpü temizletti.
NP3-VP1 :Laborant karışımı döktü.
NP3-VP3 :Laborant tüpü temizletti.

20.

a. **HighInt, Gra/Ungra:** Sunucuların muhabirlerin polisin merkez karakola götürdüğü tanığa dordukları/ ~~sordukları~~ *önemli* soruları aktardıklarını (televizyondan) biliyorum.
b. **LowInt, Gra/Ungra:** Sunucular muhabirlerin polisin ilçenin karakoluna götürdüğü tanığa dordukları/ ~~sordukları~~ *önemli* soruları aktardılar diye biliyorum.
'I know (from the television) that the presenters shared the *important* questions that the reporters asked/ ~~asked~~ the witness that the policeman took to the central police station/ district's police station.'

NP1-VP1 :Sunucular soruları aktardı.
NP1- VP3 :Sunucular tanığı götürdü.
NP3-VP1 :Polis soruları aktardı.
NP3-VP3 :Polis tanığı götürdü.

21.

a. **HighInt, Gra/Ungra:** Dekanların akademisyenlerin araştırmacının uzun raporu gönderdiği birime önerdikleri/ ~~önerdikleri~~ *geçici* çözümü duyurduklarını (yeni) duydum.
b. **LowInt, Gra/Ungra:** Dekanlar akademisyenlerin araştırmacının projenin raporunu gönderdiği birime önerdikleri/ ~~önerdikleri~~ *geçici* çözümü duyurdular diye duydum.
'I (just) heard that the deans announced the *temporary* solution that the academics proposed/ ~~proposed~~ to the unit that the researcher sent the long report/ project's report to.'

NP1-VP1 :Dekanlar çözümü duyurdu.
NP1- VP3 :Dekanlar raporu gönderdi.
NP3-VP1 :Araştırmacı çözümü duyurdu.
NP3-VP3 :Araştırmacı raporu gönderdi.

22.

a. **HighInt, Gra/Ungra:** Gitaristler**in** besteciler**in** şef**in** yeni orkestraya aldığı müzisyene bahsettikleri/ ~~bahsettikleri~~ *uzun* şarkıyı çaldıklarını (akşam) duydum.
b. **LowInt, Gra/Ungra:** Gitaristler besteciler**in** şef**in** kulübün orkestrasına aldığı müzisyene bahsettikleri/ ~~bahsettikleri~~ *uzun* şarkıyı çaldılar diye duydum.
'I heard (in the evening) that the gitarists played the *long* song that the composers mentioned/ ~~mentioned~~ to the musician that the conductor let in the new orchestra/ club's orchestra.'

NP1-VP1 :Gitaristler şarkıyı çaldı.
NP1- VP3 :Gitaristler müzisyeni aldı.
NP3-VP1 :Şef şarkıyı çaldı.
NP3-VP3 :Şef müzisyeni aldı.

23.

a. **HighInt, Gra/Ungra:** Kapıcıları**n** kiracıları**n** çevreci**nin** arka bahçeye koyduğu kutuya attıkları/ ~~attıkları~~ *plastik* çöpü boşalttıklarını (komşudan) biliyorum.
b. **LowInt, Gra/Ungra:** Kapıcılar kiracıları**n** çevreci**nin** apartmanın bahçesine koyduğu kutuya attıkları/ ~~attıkları~~ *plastik* çöpü boşalttılar diye biliyorum.
'I know (from the neighbor) that the doormen discharged the *plastic* trash that the renters threw/ ~~threw~~ into the box that the environmentalist put in the backyard/ apartment's yard.'

NP1-VP1 :Kapıcılar çöpü boşalttı.
NP1- VP3 :Kapıcılar kutuyu koydu.
NP3-VP1 :Çevreci çöpü boşalttı.
NP3-VP3 :Çevreci kutuyu koydu.

24.

a. **HighInt, Gra/Ungra:** Rehberler**in** tarihçiler**in** ressam**ın** yüklü geliri bağışladığı öğrencilere anlattıkları/ ~~anlattıkları~~ *yıkık* harabeleri gezdirdiklerini (gazetede) okudum.
b. **LowInt, Gra/Ungra:** Rehberler tarihçiler**in** ressam**ın** serginin gelirini bağışladığı öğrencilere anlattıkları/ ~~anlattıkları~~ *yıkık* harabeleri gezdirdiler diye okudum.
'I read (in the newspaper) that the tour guides showed the *demolished* ruins that the history teachers told/ ~~told~~ the students that the painter donated the huge income/ exhibition's income.'

NP1-VP1 :Rehberler harabeleri gezdirdi.
NP1- VP3 :Rehberler geliri bağışladı.
NP3-VP1 :Ressam harabeleri gezdirdi.
NP3-VP3 :Ressam geliri bağışladı.

APPENDIX D

EXPERIMENT 1: FILLER ITEMS AND COMPREHENSION STATEMENTS

Related fillers with two levels of embedding:

1. Komşuların düzenli olarak gazete okumayan kahvecinin cahil olduğunu düşündüklerini çok iyi biliyorum.

    Kahveci gazeteyi okumuyor.

2. Ebeveynler bakkalın dükkanı yeni sağlıksız ürünlerle doldurması üzerine çocuklar için endişelenmeye başladı.

    Bakkal çocukları endişelendirmiş.

3. Kırtasiyecinin dönem başında oldukça pahalıya sattığı defterlerin dönem ortasında ucuzladığının hepimiz farkındayız.

    Öğrenciler defterleri satıyor.

4. Tüm müşterilerin markette çalışan kasiyerin sürekli yanlış hesap yapmasından şikayetçi olduğu belli.

    Kasiyer mağazada çalışıyor.

5. Okula yeni gelen fizikçi dersi dinlemeyen öğrencilerin sınavdan kötü not alacaklarını biliyor.

    Fizikçi dersi anlatamıyor.

6. Yayıncının yeni çıkan kitapların çevirisi için anlaştığı çevirmenin işinde iyi olduğunu duydum.

    Yayıncı çevirmenle anlaşmış.

7. Coşkulu izleyicinin performanslarının sonunda dakikalarca alkışladığı müzisyenlerin bu konserde milyonlar kazandığını okudum.

    İzleyici müzisyeni alkışlamış.

8. Bankacının kredi çekmek için gelen müşterinin mal varlığının yeterli olmadığını söylediğini duydum.

    Banka krediyi onaylamış.

9. Müdürün öğrencilerin yurda misafir getirmelerine izin vermemesinin sebebinin önceki problemler olduğunun farkındayım.

    Müdür izni vermiyor.

10. Mühendisin şantiyede iş kazası geçiren işçinin hastaneye kaldırılmasına çok üzüldüğünü arkadaşlarından duydum.

İşçi hastaneye kaldırılmış.

11. Tecrübeli satıcının müşterinin malı satın alması için söylediklerinin ikna edici olduğunu duydum.

Müşteri malı beğenmemiş.

12. Antrenörün müsabakalara oldukça sıkı hazırlanan sporcunun doping testini geçemediğine şaşırdığını kendisinden duydum.

Sporcu müsabakada kaybetmiş.

Unrelated fillers:

1. Kuaför dükkana yeni aldığı deneyimsiz çırağın müşterilerle sıkça tartışmasına hiç ses çıkarmıyor.

Kuaför müşterilerle tartışmış.

2. Oldukça genç görünen şirket yöneticisi zinde kalabilmek için her gün spor yapıyormuş.

Yönetici spor yapıyor.

3. Ameliyatı başarılı geçince sahalara geri dönen futbolcu eski başarısını yakalamış diye duydum.

Futbolcu sahalara döndü.

4. Herkes geçen hafta başında işe başlayan mağaza müdürünü tavırları yüzünden stajyer zannetmiş.

Müdür işe başlamış.

5. Uzmanlar üniversite sınavına hazırlanan stresli lise öğrencilerine çeşitli sosyal aktivitelere katılmalarını önerdi.

Uzmanlar sınava hazırlanıyor.

6. Psikoloğun işten kovulduğu için depresyonda olan hastasına uyguladığı terapi çok işe yarıyormuş.

Comprehension statement: Psikolog terapi uyguluyor.

7. Veteriner sokakta saldırıya uğrayan yavru kediyi saatlerdir hareketsiz durduğu için öldü sanmış.

Veteriner saldırıya uğramış.

8. Tüm veliler bayram töreninde ezberden şiir okuyan çocuğun sahne heyecanını anlayışla karşıladı.

Öğretmenler törende saheyecanlandı.

9. İtfaiye yangını söndürmek için tonlarca su harcamasına rağmen ormanın büyük bölümü yandı.

Orman yangında yandı.

10. Dün gece eve camdan giren hırsızın eski evden çaldığı mücevherler oldukça pahalıymış.

Eve hırsız girmiş.

11. Annemler misafirlerin yemeğe gelirken getirdikleri şarabın eski bir Fransız şarabı olduğunu anlamadı.

Misafirler şarabı getirmiş.

12. Patron şirketin sosyal medya hesabının takipçi sayısının iki katına çıkmasına çok sevinmiş.

Patron takipçileri eklemiş.

Ungrammatical fillers:

1. Ayakta duran doktorumdaki beklemekten yorgun düşmüş refakatçiye bu sabah serum takması şaşırmadım.

Hemşire serum taktı.

2. Veliler için sınavdan geçemeyen öğrenci okulu bırakırsa öğretmeni suçlamak kolay olduğu düşünüyorlar.

Müdür öğretmeni suçlamış.

3. Kameramanınki düğünde çektiği görüntüleri sosyal medya hesaplarına anında yüklemiş mi diye duydum.

Videoyu kameraman yükledi.

4. Biz uyuşturucu kaçakçısının havaalanındaki pasaport kontrolünde olay çıkardığını dün akşam haberlerinde izlediniz.

Kaçakçı olay çıkardı.

5. Mahkumu ziyarete gelen adama göre kendisine tanınan sürenin kanunlar tarafından belirlendiğinden biliyordu.

Gardiyan mahkumu hırpaladı.

6. Kütüphaneciden dönem sonu sınavlarına hazırlanan öğrenci günlerdir çalışma salonunda sabahladığını zaten duyuldu.

Öğrenci sınavlara hazırlanıyor.

7. Genç gazeteciler otoyolda üç ölümle sonuçlanan kazayı olay yerinden canlı olarak aktarıldı.

Gazeteciler kazayı aktardı.

8. İki gün süren yolculukta yola molasız devam eden otobüsün lastiğinin patladığını görülmemiştir.

Otobüs yolda devrildi.

9. Kaptanın dediğine göre seyir halinde olan geminin limana yanaşmak için yavaşlamam gerekiyor.

Yat limana yanaşıyor.

10. Okulda kahveye gelen uçuk zam sonrası öğrenciler çaya yönelmek pek şaşırtıcı oldu.

Kahveye zam geldi.

11. Yöneticilerce projeye yeni başlayan donanımlı mimarın tecrübeli olması herkesin işini daha kolaydı.

Mimar projeye başladı.

12. İnşaatta çalışırken binanın çatısından düşen işçi kazadan sağ kurtulamadıkları dün gazetede okudum.

Yönetici çatıdan düşmüş.

APPENDIX E

EXPERIMENT 2: EXPERIMENTAL ITEMS

AND COMPREHENSION STATEMENTS

1.

a. **ENC, Gra/Ungra: Yirmili yaşlardaki**[21] garsonların müşterilerin işletmecinin yeni restorana koyduğu kutuya bıraktıkları/ ~~bıraktıkları~~[22] *yüklü*[23] bahşişi **apar topar** topladıklarını gördüm.
'I saw that the waiters **in their twenties hurriedly** collected the *loaded* tips that the customers left/ ~~left~~ in the box that the manager put in the new restaurant.'

b. **DISC, Gra/Ungra:** Garsonların müşterilerin işletmecinin **tatlılarıyla ünlü** yeni restorana **istek üzerine** koyduğu kutuya bıraktıkları/ ~~bıraktıkları~~ *yüklü* bahşişi topladıklarını gördüm.
'I (just) saw that the waiters collected the *loaded* tips that the customers left/ ~~left~~ in the box that the manager put **on request** in the new restaurant **known for its desserts**.'

NP1-VP1 :Garsonlar bahşişi topladı.
NP1- VP3 :Garsonlar kutuyu koydu.
NP3-VP1 :İşletmeci bahşişi topladı.
NP3-VP3 :İşletmeci kutuyu koydu.

2.

a. **ENC, Gra/Ungra: İşinin ehli** marangozların nakliyecilerin kiracının gri koltuğu yerleştirdiği odaya taşıdıkları/ ~~taşıdıkları~~ *ahşap* dolabı **iki saatte** kurduklarını gördüm.
'I saw that the **expert** carpenters **in two hours** built the *wooden* closet that the movers moved/ ~~moved~~ to the room that the tenant placed the gray sofa.'

b. **DISC, Gra/Ungra:** Marangozların nakliyecilerin kiracının **oldukça geniş** gri koltuğu **büyük özenle** yerleştirdiği odaya taşıdıkları/ ~~taşıdıkları~~ *ahşap* dolabı kurduklarını gördüm.
'I saw that the carpenters built the *wooden* closet that the movers moved/ ~~moved~~ to the room that the renter placed the **extremely large** gray sofa in **with great care**.'

NP1-VP1 :Marangozlar dolabı kurdu.
NP1- VP3 :Marangozlar koltuğu yerleştirdi.
NP3-VP1 :Kiracı dolabı kurdu.
NP3-VP3 :Kiracı koltuğu yerleştirdi.

3.

[21] Bolded words are added in order to lengthen the phrases for Encouraging and Discouraging Phrase Lengths conditions.
[22] The verbs that are strikethrough are omitted in the ungrammatical conditions.
[23] Italic words are added in place of omitted verbs in the ungrammatical conditions.

a. **ENC, Gra/Ungra: İşinde acemi** çırakların boyacıların satıcının yeni müdüre gösterdiği mobilyaya sürdükleri/ ~~sürdükleri~~ *yağlı* boyayı **dikkatsiz şekilde** döktüklerine üzüldüm.
'I felt sorry that the **inexperienced** apprentices **carelessly** spilled the *oil* paint that the painters applied/ ~~applied~~ to the furniture that the salesperson showed to the new manager.'

b. **DISC, Gra/Ungra:** Çırakların boyacıların satıcının **takım elbiseli** yeni müdüre **dün akşam** gösterdiği mobilyaya sürdükleri/ ~~sürdükleri~~ *yağlı* boyayı döktüklerine üzüldüm.
'I felt sorry that the apprentices spilled the *oil* paint that the painters applied/ ~~applied~~ to the furniture that the salesperson **in suit** showed to the new manager **last night**.'

NP1-VP1 :Çıraklar boyayı döktü.
NP1- VP3 :Çıraklar mobilyayı gösterdi.
NP3-VP1 :Satıcı boyayı döktü.
NP3-VP3 :Satıcı mobilyayı gösterdi.

4.

a. **ENC, Gra/Ungra: Olaya tekili** velilerin öğretmenlerin matematikçinin üst kurula gönderdiği öğrenciye verdikleri/ ~~verdikleri~~ *ağır* cezayı **birkaç defa** hatırlattıklarını anladım.
'I understood that the parents **reacting to the situation** reminded **a few times** the *severe* punishment that the teachers gave/ ~~gave~~ to the student that the math teacher sent to the supreme board.'

b. **DISC, Gra/Ungra:** Velilerin öğretmenlerin matematikçinin **oldukça katı** üst kurula **geçen hafta** gönderdiği öğrenciye verdikleri/ ~~verdikleri~~ *ağır* cezayı hatırlattıklarını anladım.
'I understood that the parents reminded the *severe* punishment that the teachers gave/ ~~gave~~ to the student that the math teacher sent to the **quite strict** supreme board **last week**.'

NP1-VP1 :Veliler cezayı hatırlattı.
NP1- VP3 :Veliler öğrenciyi gönderdi.
NP3-VP1 :Matematikçi cezayı hatırlattı.
NP3-VP3 :Matematikçi öğrenciyi gönderdi.

5.

a. **ENC, Gra/Ungra: Güvenlik kılığındaki** hırsızların yazılımcıların müdürün yeni ofise aldığı bilgisayara yükledikleri/ ~~yükledikleri~~ *büyük* dosyayı **herkesten gizli** kopyaladıklarına şaşırıyorum.
'I am shocked that the thieves **dressed as security secretly** copied the *big* document that the software developers downloaded/ ~~downloaded~~ to the computer that the manager bought for the new office.'

b. **DISC, Gra/Ungra:** Hırsızların yazılımcıların müdürün **üst kattaki** yeni ofise **geçen ay** aldığı bilgisayara yükledikleri/ ~~yükledikleri~~ *büyük* dosyayı kopyaladıklarına şaşırıyorum.

'I am shocked that the thieves copied the *big* document that the software developers downloaded/ ~~downloaded~~ to the computer that the manager bought for the new office **upstairs last month**.'

NP1-VP1 :Hırsızlar dosyayı kopyaladı.
NP1- VP3 :Hırsızlar bilgisayar aldı.
NP3-VP1 :Müdür dosyayı kopyaladı.
NP3-VP3 :Müdür bilgisayar aldı.

6.

a. **ENC, Gra/Ungra: Nöbetçi eczanedeki** eczacıların doktorların hemşirenin ilaçlı serumu taktığı hastaya yazdıkları/ ~~yazdıkları~~ *uzun* reçeteyi **uzun uzun** açıkladıklarını öğrendim.
'I learned that the pharmacists **at the pharmacy on duty** explained **at length** the *long* prescription that the doctors wrote/ ~~wrote~~ to the patient that the nurse put the medicated IV on.'

b. **DISC, Gra/Ungra:** Eczacıların doktorların hemşirenin **ağrı kesici** ilaçlı serumu **dün akşam** taktığı hastaya yazdıkları/ ~~yazdıkları~~ *uzun* reçeteyi açıkladıklarını öğrendim.
'I learned that the pharmacists explained the *long* prescription that the doctors wrote/ ~~wrote~~ to the patient that the nurse put the **painkiller** IV on **last night**.'

NP1-VP1 :Eczacılar reçeteyi açıkladı.
NP1- VP3 :Eczacılar serumu taktı.
NP3-VP1 :Hemşireler reçeteyi açıkladı.
NP3-VP3 :Hemşireler serumu taktı.

7.

a. **ENC, Gra/Ungra: Mavi üniformalı** hemşirelerin doktorların hastanın genç eczacıya gösterdiği yaraya önerdikleri/ ~~önerdikleri~~ *koruyucu* merhemi **pamuk yardımıyla** sürdüklerine sevindim.
'I got happy that the nurses **in blue uniform** applied **with cotton** the *protective* salve that the doctors recommended/ ~~recommended~~ for the scar that the patient showed to the young pharmacist.'

b. **DISC, Gra/Ungra:** Hemşirelerin doktorların hastanın **kısa saçlı** genç eczacıya **dün sabah** gösterdiği yaraya önerdikleri/ ~~önerdikleri~~ *koruyucu* merhemi sürdüklerine sevindim.
'I got happy that the nurses applied the *protective* salve that the doctors recommended/ ~~recommended~~ for the scar that the patient showed to the young pharmacist **with short hair yesterday morning**.'

NP1-VP1 :Hemşireler merhemi sürdü.
NP1- VP3 :Hemşireler yarayı gösterdi.
NP3-VP1 :Hasta merhemi sürdü.
NP3-VP3 :Hasta yarayı gösterdi.

8.

a. **ENC, Gra/Ungra: Üniversite öğrencisi** asistanların editörlerin edebiyatçının ilgili okuyuculara önerdiği siteye yazdıkları/ ~~yazdıkları~~ *detaylı* makaleyi **az önce** yüklediklerine sevindim.
'I got happy that the **university student** assistants **just** uploaded the *detailed* article that the editors wrote/ ~~wrote~~ for the website that the men of letters recommended to the interested readers.'

b. **DISC, Gra/Ungra:** Asistanların editörlerin edebiyatçının **şiire meraklı** genç okuyuculara **yeni sayıda** önerdiği siteye yazdıkları/ ~~yazdıkları~~ *detaylı* makaleyi yüklediklerine sevindim.
'I got happy that the assistants uploaded the *detailed* article that the editors wrote/ ~~wrote~~ for the website that the men of letters recommended to the young readers **who are into poetry in the new issue**.'

NP1-VP1 :Asistanlar makalayi yükledi.
NP1- VP3 :Asistanlar siteyi önerdi.
NP3-VP1 :Edebiyatçı makaleyi yükledi.
NP3-VP3 :Edebiyatçı siteyi önerdi.

9.

a. **ENC, Gra/Ungra: Eli çabuk** terzilerin modacıların menajerin saygın yapımcıya tanıttığı mankene tasarladıkları/ ~~tasarladıkları~~ *gösterişli* elbiseyi **iki günde** diktiklerini hatırlıyorum.
'I remember that the **fast-working** tailors **in two days** sewed the *ostentatious* dress that the stylists designed/ ~~designed~~ for the model that the manager introduced to the honorable producer.'

b. **DISC, Gra/Ungra:** Terzilerin modacıların menajerin **dünyaca ünlü** saygın yapımcıya **yeni ajansta** tanıttığı mankene tasarladıkları/ ~~tasarladıkları~~ *gösterişli* elbiseyi diktiklerini hatırlıyorum.
'I remember that the tailors sewed the *ostentatious* dress that the stylists designed/ ~~designed~~ for the model that the manager introduced to the **world-famous** honorable producer **in the new agency**.'

NP1-VP1 :Terziler elbiseyi dikti.
NP1- VP3 :Terziler mankeni tanıttı.
NP3-VP1 :Menajer elbiseyi dikti.
NP3-VP3 :Menajger mankeni tanıttı.

10.

a. **ENC, Gra/Ungra: Oldukça titiz** eleştirmenlerin kameramanların yapımcının yeni çekimlere çağırdığı yönetmene hazırladıkları/ ~~hazırladıkları~~ *tanıtıcı* klibi **detaylı şekilde** yorumladıklarını okudum.
'I read that the **quite meticulous** critics **in detail** reviewed the *introductory* video that the cameramen prepared/ ~~prepared~~ for the director that the producer invited to the new shot.'

b. **DISC, Gra/Ungra:** Eleştirmenlerin kameramanların yapımcının **bu sezonki** yeni çekimlere **telefon ile** çağırdığı yönetmene hazırladıkları/ ~~hazırladıkları~~ *tanıtıcı* klibi yorumladıklarını okudum.

‘I read that the critics reviewed the *introductory* video that the cameramen prepared/ ~~prepared~~ for the director that the producer invited to **this season’s** new shot **on the phone**.’

NP1-VP1 :Eleştirmenler klibi yorumladı.
NP1- VP3 :Eleştirmenler yönetmeni çağırdı.
NP3-VP1 :Yapımcı klibi yorumladı.
NP3-VP3 :Yapımcı yönetmeni çağırdı.

11.

a. **ENC, Gra/Ungra: Orta yaşlı** savcıların avukatların muhasebecinin yeni belgeleri sunduğu hakime savundukları/ ~~savundukları~~ *büyük* yolsuzluğu **sakin şekilde** açıkladıklarını biliyorum.
‘I know that the **middle-aged** prosecutors **calmly** declared the *big* corruption that the attorneys defended/ ~~defended~~ to the judge that the accountant presented the new documents to.’

b. **DISC, Gra/Ungra:** Savcıların avukatların muhasebecinin **ıslak imzalı** yeni belgeleri **dünkü toplantıda** sunduğu hakime savundukları/ ~~savundukları~~ *büyük* yolsuzluğu açıkladıklarını biliyorum.
‘I know that the prosecutors declared the *big* corruption that the attorneys defended/ ~~defended~~ to the judge that the accountant presented the new documents **with wet signature** to **in yesterday’s meeting**.’

NP1-VP1 :Savcılar yolsuzluğu açıkladı.
NP1- VP3 :Savcılar belgeleri sundu.
NP3-VP1 :Muhasebeci yolsuzluğu açıkladı.
NP3-VP3 :Muhasebeci belgeleri sundu.

12.

a. **ENC, Gra/Ungra: Oldukça sabırlı** hosteslerin güvenliklerin pilotun sağ çıkışa yönlendirdiği yolcuya yaptıkları/ ~~yaptıkları~~ *sözlü* uyarıyı **birkaç kez** tekrarladıklarını duydum.
‘I heard that the **quite patient** flight attendants **a few times** repeated the *oral* warning that the security gave/ ~~gave~~ to the passenger that the pilot directed to the exit on the right.’

b. **DISC, Gra/Ungra:** Hosteslerin güvenliklerin pilotun **kırmızı ışıklı** sağ çıkışa **acil olarak** yönlendirdiği yolcuya yaptıkları/ ~~yaptıkları~~ *sözlü* uyarıyı tekrarladıklarını duydum.
‘I heard that the flight attendants repeated the *oral* warning that the security gave/ ~~gave~~ to the passenger that the pilot **urgently** directed to the exit on the right **with red light**.’

NP1-VP1 :Hostesler uyarıyı tekrarladı.
NP1- VP3 :Hostesler yolcuyu yönlendirdi.
NP3-VP1 :Pilot uyarıyı tekrarladı.
NP3-VP3 :Pilot yolcuyu yönlendirdi.

13.

a. **ENC, Gra/Ungra: Aşırı yorgun** temizlikçilerin işletmecilerin şoförün yeni servisi gösterdiği turiste ayırdıkları/ ~~ayırdıkları~~ *özel* odayı **yavaş yavaş** hazırladıklarına sevindim.
‘I became happy that the **extremely tired** cleaners **slowly** prepared the *private* room that the managers reserved/ ~~reserved~~ for the tourist that the driver showed the new shuttle.’

b. **DISC, Gra/Ungra:** Temizlikçilerin işletmecilerin şoförün **otele ait** yeni servisi **el işaretiyle** gösterdiği turiste ayırdıkları/ ~~ayırdıkları~~ *özel* odayı hazırladıklarına sevindim.
‘I became happy that the cleaners prepared the *private* room that the managers reserved/ ~~reserved~~ for the tourist that the driver showed the new shuttle **of the hotel with a hand sign**.’

NP1-VP1 :Temizlikçiler odayı hazırladı.
NP1- VP3 :Temizlikçiler servisi gösterdi.
NP3-VP1 :Şoför odayı hazırladı.
NP3-VP3 :Şoför servisi gösterdi.

14.

a. **ENC, Gra/Ungra: Hayvan dostu** yetkililerin veterinerlerin köylünün büyük barınağa getirdiği köpeğe yazdıkları/ ~~yazdıkları~~ *yeni* ilacı **komşu ilçeden** ısmarladıklarına sevindim.
‘I became happy that the **animal-lover** officials ordered **from the neighbour district** the *new* medicine that the vets prescribed/ ~~prescribed~~ for the dog that the villager brought to the big shelter.’

b. **DISC, Gra/Ungra:** Yetkililerin veterinerlerin köylünün **ilçe merkezindeki** büyük barınağa **otobüs ile** getirdiği köpeğe yazdıkları/ ~~yazdıkları~~ *yeni* ilacı ısmarladıklarına sevindim.
‘I became happy that the officials ordered the *new* medicine that the vets prescribed/ ~~prescribed~~ for the dog that the villager brought to the big shelter **at the city center by bus**.’

NP1-VP1 :Yetkililer ilacı ısmarladı.
NP1- VP3 :Yetkililer köpeği getirdi.
NP3-VP1 :Köylü ilacı ısmarladı.
NP3-VP3 :Köylü köpeği getirdi.

15.

a. **ENC, Gra/Ungra: Orta yaşlı** hizmetçilerin perdecilerin bakıcının demir başlığı taşıdığı odaya diktikleri/ ~~diktikleri~~ *ince* tülü **temizlik sonrası** astıklarını gördüm.
‘I saw that the **middle-aged** maids hung the *fine* tulle curtains that the curtain sellers sewed/ ~~sewed~~ for the room that the caretaker moved the iron headboard **after cleaning**.’

b. **DISC, Gra/Ungra:** Hizmetçilerin perdecilerin bakıcının **beyaz renkli** demir başlığı **zar zor** taşıdığı odaya diktikleri/ ~~diktikleri~~ *ince* tülü astıklarını gördüm.

'I saw that the maids hung the *fine* tulle curtains that the curtain sellers sewed/ ~~sewed~~ for the room that the caretaker moved the **white** iron headboard **with difficulty**.'

NP1-VP1 :Hizmetçiler tülü astı.
NP1- VP3 :Hizmetçiler başlığı taşıdı.
NP3-VP1 :Bakıcı tülü astı.
NP3-VP3 :Bakıcı başlığı taşıdı.

16.

a. **ENC, Gra/Ungra: Sokaktaki evsiz** dilencilerin çocukların çöpçünün ön kapıya bıraktığı kutuya fırlattıkları/ ~~fırlattıkları~~ *eski* oyuncakları **sevinç içinde** topladıklarını hatırlıyorum.
'I remember that the **homeless** beggars **on the street with great joy** collected the *old* toys that the kids threw/ ~~threw~~ into the box that the garbageman left at the front door.'

b. **DISC, Gra/Ungra:** Dilencilerin çocukların çöpçünün **mermer taşlı** ön kapıya **temizlik sonrası** bıraktığı kutuya fırlattıkları/ ~~fırlattıkları~~ *eski* oyuncakları topladıklarını hatırlıyorum.
'I remember that the beggars collected the *old* toys that the kids threw/ ~~threw~~ into the box that the garbageman left at the **marble** front door **after cleaning**.'

NP1-VP1 :Dilenciler oyuncakları topladı.
NP1- VP3 :Dilenciler kutuyu bıraktı.
NP3-VP1 :Çöpçü oyuncakları topladı.
NP3-VP3 :Çöpçü kutuyu bıraktı.

17.

a. **ENC, Gra/Ungra: Eli çabuk** aranjörlerin bestecilerin organizatörün dünkü toplantıya çağırdığı şarkıcıya verdikleri/ ~~verdikleri~~ *yeni* besteyi **bir günde** düzenlediklerini duydum.
'I heard that the **fast-working** arrangers **in one day** arranged the *new* composition that the composers gave/ ~~gave~~ to the singer that the promoter invited to the yesterday's meeting.'

b. **DISC, Gra/Ungra:** Aranjörlerin bestecilerin organizatörün **genel merkezdeki** büyük toplantıya **özel olarak** çağırdığı şarkıcıya verdikleri/ ~~verdikleri~~ *yeni* besteyi düzenlediklerini duydum.
'I heard that the arrangers arranged the *new* composition that the composers gave/ ~~gave~~ to the singer that the promoter invited to the big meeting **at the head office privately**.'

NP1-VP1 :Aranjörler besteyi düzenledi.
NP1- VP3 :Aranjörler şarkıcıyı çağırdı.
NP3-VP1 :Organizatör besteyi düzenledi.
NP3-VP3 :Organizatör şarkıcıyı çağırdı.

18.

a. **ENC, Gra/Ungra: Okuldaki yeni** öğretmenlerin sanatçıların müdürün diğer kuruma bildirdiği öğrencilere gönderdikleri/ ~~gönderdikleri~~ *küçük* hediyeleri **birer birer** paylaştırdıklarına sevindim.
'I became happy that the **new** teachers **at school one by one** alloted the *small* presents that the artists sent/ ~~sent~~ to the students that the principal reported to the other organization.'

b. **DISC, Gra/Ungra:** Öğretmenlerin sanatçıların müdürün **eğitim odaklı** diğer kuruma **dilekçe ile** bildirdiği öğrencilere gönderdikleri/ ~~gönderdikleri~~ *küçük* hediyeleri paylaştırdıklarına sevindim.
'I became happy that the teachers alloted the *small* presents that the artists sent/ ~~sent~~ to the students that the principal reported to the other **education-focused** organization **with petition**.'

NP1-VP1 :Öğretmenler hediyeleri paylaştırdı.
NP1- VP3 :Öğretmenler öğrencileri bildirdi.
NP3-VP1 :Müdür hediyeleri paylaştırdı.
NP3-VP3 :Müdür öğrencileri bildirdi.

19.

a. **ENC, Gra/Ungra: Deneyden sorumlu** asistanların kimyagerlerin laborantın genç stajyere temizlettiği tüpe doldurdukları/ ~~doldurdukları~~ *beyaz* karışımı **az önce** döktüklerini duydum.
'I heard that the assistants **responsible for the experiment just** spilled the *white* mixture that the chemists filled/ ~~filled~~ the tube with that the laborant made the young intern clean.'

b. **DISC, Gra/Ungra:** Asistanların kimyagerlerin laborantın **deneyden sorumlu** genç stajyere **zar zor** temizlettiği tüpe doldurdukları/ ~~doldurdukları~~ *beyaz* karışımı döktüklerini duydum.
'I heard that the assistants spilled the *white* mixture with which the chemists filled/ ~~filled~~ the tube that the laborant made the young intern **responsible for the experiment** clean **with difficulty**.'

NP1-VP1 :Asistanlar karışımı döktü.
NP1- VP3 :Asistanlar tüpü temizletti.
NP3-VP1 :Laborant karışımı döktü.
NP3-VP3 :Laborant tüpü temizletti.

20.

a. **ENC, Gra/Ungra: Olay yerindeki** sunucuların muhabirlerin polisin merkez karakola götürdüğü tanığa sordukları/ ~~sordukları~~ *önemli* soruları **canlı yayında** aktardıklarını biliyorum.
'I know that the presenters **at the scene** shared **on live broadcast** the *important* questions that the reporters asked/ ~~asked~~ the witness that the policeman took to the central police station.'

b. **DISC, Gra/Ungra:** Sunucuların muhabirlerin polisin **şehir merkezindeki** büyük karakola **polis arabasında** götürdüğü tanığa sordukları/ ~~sordukları~~ *önemli* soruları aktardıklarını biliyorum.

'I know that the presenters shared the *important* questions that the reporters asked/ ~~asked~~ the witness that the policeman took to the big police station **at the city centre in a police car**.'

NP1-VP1 :Sunucular soruları aktardı.
NP1- VP3 :Sunucular tanığı götürdü.
NP3-VP1 :Polis soruları aktardı.
NP3-VP3 :Polis tanığı götürdü.

21.

a. **ENC, Gra/Ungra: Etik kuruldaki** dekanların akademisyenlerin araştırmacının uzun raporu gönderdiği birime önerdikleri/ ~~önerdikleri~~ *geçici* çözümü **üniversite bülteninde** duyurduklarını duydum.
'I heard that the deans **at the ethical committee** announced **at the university bulletin** the *temporary* solution that the academics proposed/ ~~proposed~~ to the unit that the researcher sent the long report.'
b. **DISC, Gra/Ungra:** Dekanların akademisyenlerin araştırmacının **yirmi sayfalık** uzun raporu **posta yoluyla** gönderdiği birime önerdikleri/ ~~önerdikleri~~ *geçici* çözümü duyurduklarını duydum.
'I heard that the deans announced the *temporary* solution that the academics proposed/ ~~proposed~~ to the unit that the researcher sent the **twenty-page** long report **by post**.'

NP1-VP1 :Dekanlar çözümü duyurdu.
NP1- VP3 :Dekanlar raporu gönderdi.
NP3-VP1 :Araştırmacı çözümü duyurdu.
NP3-VP3 :Araştırmacı raporu gönderdi.

22.

a. **ENC, Gra/Ungra: Üstün yetenekli** gitaristlerin bestecilerin şefin yeni orkestraya aldığı müzisyene bahsettikleri/ ~~bahsettikleri~~ *uzun* şarkıyı **ahenk içinde** çaldıklarını duydum.
'I heard that the **gifted** gitarists played **in harmony** the *long* song that the composers mentioned/ ~~mentioned~~ to the musician that the conductor let in the new orchestra.'
b. **DISC, Gra/Ungra:** Gitaristlerin bestecilerin şefin **konser grubundaki** yeni orkestraya **geçen ay** aldığı müzisyene bahsettikleri/ ~~bahsettikleri~~ *uzun* şarkıyı çaldıklarını duydum.
'I heard that the gitarists played the *long* song that the composers mentioned/ ~~mentioned~~ to the musician that the conductor let in the new orchestra **in the concert group last month**.'

NP1-VP1 :Gitaristler şarkıyı çaldı.
NP1- VP3 :Gitaristler müzisyeni aldı.
NP3-VP1 :Şef şarkıyı çaldı.
NP3-VP3 :Şef müzisyeni aldı.

23.

a. **ENC, Gra/Ungra: Temizlikten sorumlu** kapıcıların kiracıların çevrecinin arka bahçeye koyduğu kutuya attıkları/ ~~attıkları~~ *plastik* çöpü **gece yarısı** boşalttıklarını biliyorum.
‘I know that the doormen **responsible for cleaning** discharged **in the middle of the night** the *plastic* trash that the renters threw/ ~~threw~~ into the box that the environmentalist put in the backyard.’

b. **DISC, Gra/Ungra:** Kapıcıların kiracıların çevrecinin **dağınık haldeki** arka bahçeye **dün gece** koyduğu kutuya attıkları/ ~~attıkları~~ *plastik* çöpü boşalttıklarını biliyorum.
‘I know that the doormen discharged the *plastic* trash that the renters threw/ ~~threw~~ into the box that the environmentalist put in the **messy** backyard **last night**.’

NP1-VP1 :Kapıcılar çöpü boşalttı.
NP1- VP3 :Kapıcılar kutuyu koydu.
NP3-VP1 :Çevreci çöpü boşalttı.
NP3-VP3 :Çevreci kutuyu koydu.

24.

a. **ENC, Gra/Ungra: İlçedeki uzman** rehberlerin tarihçilerin ressamın yüklü geliri bağışladığı öğrencilere anlattıkları/ ~~anlattıkları~~ *yıkık* harabeleri **grup halinde** gezdirdiklerini okudum.
‘I read that the **expert** tour guides **at the county** showed the *demolished* ruins that the history teachers told/ ~~told~~ the students that the painter donated the huge income.’

b. **DISC, Gra/Ungra:** Rehberlerin tarihçilerin ressamın **bağış fonundaki** yüklü geliri **gönüllü olarak** bağışladığı öğrencilere anlattıkları/ ~~anlattıkları~~ *yıkık* harabeleri gezdirdiklerini okudum.
‘I read that the tour guides showed the *demolished* ruins that the history teachers told/ ~~told~~ the students that the painter donated the huge income **in the endowment fund voluntarily**.’

NP1-VP1 :Rehberler harabeleri gezdirdi.
NP1- VP3 :Rehberler geliri bağışladı.
NP3-VP1 :Ressam harabeleri gezdirdi.
NP3-VP3 :Ressam geliri bağışladı.

APPENDIX F

EXPERIMENT 2: FILLER ITEMS AND COMPREHENSION STATEMENTS

Related fillers with two levels of embedding:

1. Yan apartmandaki komşuların düzenli olarak gazete okumayan kahvecinin cahil olduğunu düşündüklerini herkesten daha iyi biliyorum.

Kahveci gazeteyi okumuyor.

2. Sağlığa duyarlı ebeveynler bakkalın dükkanı sağlıksız abur cubur ürünlerle doldurması üzerine çocuklar için endişelenmeye başladı.

Bakkal çocukları endişelendirmiş.

3. Paragöz kırtasiyecinin dönem başında oldukça pahalıya sattığı renkli defterlerin dönem ortasına doğru ucuzladığının hepimiz farkındayız.

Öğrenciler defterleri satıyor.

4. Alışverişe gelen tüm müşterilerin markette çalışan kasiyerin yanlış hesap yapıp fiş kesmemesinden şikayetçi olduğunu duydum.

Kasiyer mağazada çalışıyor.

5. Okula yeni gelen fizikçi dersi dinlemeyip aralarında konuşan tembel öğrencilerin sınavdan kötü not alacaklarını biliyor.

Fizikçi dersi anlatamıyor.

6. Yayıncının geçen ay çıkan yeni kitapların çevirisi için anlaştığı genç çevirmenin işinde iyi olduğunu duydum.

Yayıncı çevirmenle anlaşmış.

7. Coşkulu izleyicinin performanslarının sonunda dakikalar boyunca alkışladığı başarılı müzisyenlerin bu konserde milyonlar kazandığını gazetede okudum.

İzleyici müzisyeni alkışlamış.

8. Bankacının kredi çekmek için gelen üç aydır çalışmayan müşterinin mal varlığının yeterli olmadığını söylediğini duydum.

Banka krediyi onaylamış.

9. Müdürün öğrencilerin yurda misafir getirmelerine izin vermemesinin asıl sebebinin geçen senelerde yaşanan problemler olduğunun farkındayım.

Müdür izni vermiyor.

10. Mühendisin şantiyede çalışırken iş kazası geçiren oldukça genç işçinin hastaneye kaldırılmasına çok üzüldüğünü arkadaşlarından duydum.

İşçi hastaneye kaldırılmış.

11. Tecrübeli satıcının müşterinin dükkana sabah gelen malı satın alması için söylediklerinin ikna edici olduğunu duydum.

Müşteri malı beğenmemiş.

12. Antrenörün gelecek haftaki müsabakalara oldukça sıkı hazırlanan azimli sporcunun doping testini geçemediğine şaşırdığını kendisinden duydum.

Sporcu müsabakada kaybetmiş.

Unrelated fillers:

1. Tecrübeli ve anlayışlı kuaför dükkana yeni aldığı deneyimsiz çırağın müşterilerle sıkça tartışmasına hiç ses çıkarmıyor.

Müşterilerle kuaför tartışmış.

2. Oldukça genç görünen şirket yöneticisi fit formunu korumak için düzenli olarak her gün spor yapıyormuş.

Yönetici spor yapıyor.

3. Sakatlığı sonucu geçirdiği ameliyatı başarılı geçince sahalara geri dönen futbolcunun eski başarısını yakaladığı gazetede yazıyor.

Futbolcu sahalara döndü.

4. Geçen hafta işe başlayan mağaza müdürünün katıldığı toplantıda deneyimsiz tavırları yüzünden stajyer zannedildiğini iddia ediyorlar.

Müdür toplantıya katılmış.

5. Uzmanlar üniversite sınavına hazırlanan lise öğrencilerine hızla artan stres seviyelerini azaltmaları için sosyal aktiviteler önerdi.

Uzmanlar sınava hazırlanıyor.

6. Deneyimli psikoloğun eşinden boşandığı için ağır depresyonda olan hastasına uyguladığı terapinin işe yaramaya başladığı düşünülüyor.

Psikolog terapi uyguluyor.

7. Veteriner arka sokakta köpekler tarafından saldırıya uğrayan yavru kediyi saatlerdir hareketsiz durduğu için öldü sanmış.

Veteriner saldırıya uğramış.

8. Tüm veliler geçen haftaki bayram töreninde ezberden şiir okuyan küçük çocuğun sahne heyecanını anlayışla karşıladı.

Öğretmenler törende heyecanlandı.

9. Şehir dışındaki ormanın çok büyük bölümü itfaiye yangını söndürmek için tonlarca su harcamasına rağmen yandı.

Orman yangında yandı.

10. Dün gece geç saatlerde eve giren hırsızın sanatçının göl kenarındaki evinden çaldığı mücevherler oldukça pahalıymış.

Eve hırsız girmiş.

11. Misafirlerin akşam yemeğine gelirken getirdikleri kırmızı etiketli şarabın eski bir Fransız şarabı olduğunu fark etmemişler.

Misafirler şarap getirmiş.

12. Patron şirketin sosyal medya hesabının takipçi sayısının geçen yıla kıyasla tam iki katına çıkmasına çok sevinmiş.

Patron takipçileri eklemiş.

Ungrammatical fillers:

1. Ayakta duran hastayı gece beklemekten yorgun düşmüş refakatçiye hemşireler tarafından ağrı kesici iğne yapılmasına şaşırmadım.

Hasta serum taktı.

2. Veli matematik sınavından tembel geçemeyen öğrenci orta okulu bırakırsa öğretmeni suçlamak herkes için kolay olur.

Veli öğretmeni suçlamış.

3. Genç fotoğrafçılarda işinde titiz kameraman düğünde çektiği görüntüleri sosyal medya hesaplarına anında yükledi diye duydum.

Kameraman fotoğrafları yükledi.

4. Polislere uyuşturucu kaçakçısının havaalanındaki yurtdışı giriş kontrolünde büyük bir olay çıkardığını dün akşam haberlerinde izledim.

Kaçakçı olay çıkardı.

5. Uzun boylu gardiyan mahkumu ziyarete gelen yaşlı adama tanınan sürenin kanunlar tarafından belirlendiğini zaten biliyordu.

Gardiyan mahkumu hırpaladı.

6. İhtiyar kütüphaneci dönem sonu final sınavlarına hazırlanan çalışkan öğrencinin günlerdir çalışma salonunda sabahladığını arkadaşlarından duydum.

Öğrenci sınavlara hazırlanıyor.

7. Korkusuz gazeteciler muhabir otoyolda üç ölümle sonuçlanan tüyler ürpertici kazayı olay yerinden canlı olarak aktardı.

Muhabir kazayı aktardı.

8. Beyaz gömlekli muavin on saat süren yolculukta yola molasız devam eden otobüsün lastiğinin patladığını görmedim.

Otobüs yolda devrildi.

9. Kaptan seyir halinde olan üç katlı büyük geminin limana yanaşmak için iki saatinin kaldığını anlamamıştım.

Yat limana yanaşıyor.

10. Kantinci filtre kahveye bu hafta gelen uçuk zam sonrası öğrencilerin çaya yönelmeleri pek şaşırtıcı olmadı.

Kahveye zam geldi.

11. Alanında uzman yöneticiler büyük projeye yeni başlayan donanımlı mimarın tecrübeli olması herkesin işini çok kolaylaştırıyor.

Mimar projeye başladı.

12. Oldukça üzgün görünen işçi inşaatta çalışırken binanın çatısından düşen elektrikçinin kazadan sağ kurtulamadığını gazetede okudum.

İşçi çatıdan düşmüş.

APPENDIX G

EXPERIMENT 3: EXPERIMENTAL ITEMS

AND COMPREHENSION QUESTIONS

1.

a. **HighSyn-HighPhono, ENC:** *Yirmili yaşlardaki*[24] garsonları**n**[25] müşteriler**in** işletmeci**nin** yeni restorana koyduğu kutuya bıraktıkları bahşişi *apar topar* topladıklarını sandım. Yanlış görmüşüm.

b. **LowSyn-HighPhono, ENC:** *Yirmili yaşlardaki* garsonlar müşteriler**in** işletmeci**nin** rezidasnsı**n** restoranına koyduğu kutuya bıraktıkları bahşişi *apar topar* topladılar sandım. Yanlış görmüşüm.

c. **LowSyn-LowPhono, ENC:** *Yirmili yaşlardaki* garsonlar müşteriler**in** işletmeci**nin** yeni restorana koyduğu kutuya bıraktıkları bahşişi *apar topar* topladılar sandım. Yanlış görmüşüm.
'I thought that the waiters *in their twenties hurriedly* collected the tips that the customers left in the box that the manager put in the new restaurant/ residence's restaurant. Apparently I was wrong.'

d. **HighSyn-HighPhono, DISC:** Garsonları**n** müşteriler**in** işletmeci**nin** *tatlılarıyla ünlü* yeni restorana *istek üzerine* koyduğu kutuya bıraktıkları bahşişi topladıklarını sandım. Yanlış görmüşüm.

e. **LowSyn-HighPhono, DISC:** Garsonlar müşteriler**in** işletmeci**nin** rezidansı**n** *tatlılarıyla ünlü* restoranına *istek üzerine* koyduğu kutuya bıraktıkları bahşişi topladılar sandım. Yanlış görmüşüm.

f. **LowSyn-LowPhono, DISC:** Garsonlar müşteriler**in** işletmeci**nin** *tatlılarıyla ünlü* yeni restorana *istek üzerine* koyduğu kutuya bıraktıkları bahşişi topladılar sandım. Yanlış görmüşüm.
'I thought that the waiters collected the tips that the customers left in the box that the manager put *on request* in the new restaurant/ residence's restaurant *known for its desserts*. Apparently I was wrong.'

NP6 :Kutu koyuldu mu?
NP7 :Bahşiş unutuldu mu?

2.

a. **HighSyn-HighPhono, ENC:** *İşinin ehli* marangozları**n** nakliyeciler**in** kiracı**nın** gri koltuğu yerleştirdiği odaya taşıdıkları dolabı *iki saatte* kurduklarını sandım. Yakında taşınacaklardı.

b. **LowSyn-HighPhono, ENC:** *İşinin ehli* marangozlar nakliyeciler**in** kiracı**nın** koltuğ**un** minderlerini yerleştirdiği odaya taşıdıkları dolabı *iki saatte* kurdular sandım. Yakında taşınacaklardı.

[24] Words in italic are added to lengthen the contributing phrases for the Encouraging and Discouraging Phrase Lengths conditions.
[25] Genitive case manipulating syntactic or phonological interference is given in bold.

c. **LowSyn-LowPhono, ENC:** *İşinin ehli* marangozlar nakliyeciler**in** kiracı**nın** gri koltuğu yerleştirdiği odaya taşıdıkları dolabı *iki saatte* kurdular sandım. Yakında taşınacaklardı.
'I thought that the *expert* carpenters *in two hours* built the closet that the movers moved to the room that the renter placed the gray sofa/ sofa's cushions in. They were going to move in soon.'

d. **HighSyn-HighPhono, DISC:** Marangozları**n** nakliyeciler**in** kiracı**nın** *koyu renkli* gri koltuğu *büyük özenle* yerleştirdiği odaya taşıdıkları dolabı kurduklarını sandım. Yakında taşınacaklardı.

e. **LowSyn-HighPhono, DISC:** Marangozlar nakliyeciler**in** kiracı**nın** koltuğ**un** *koyu renkli* minderlerini *büyük özenle* yerleştirdiği odaya taşıdıkları dolabı kurdular sandım. Yakında taşınacaklardı.

f. **LowSyn-HighPhono, DISC:** Marangozlar nakliyeciler**in** kiracı**nın** *koyu renkli* gri koltuğu *büyük özenle* yerleştirdiği odaya taşıdıkları dolabı kurdular sandım. Yakında taşınacaklardı.
'I thought that the carpenters built the closet that the movers moved to the room that the renter placed the *dark-colored* gray sofa/ sofa's cushions in *with great care*. They were going to move in soon.'

NP6 :Oda boyandı mı?
NP7 :Dolap taşındı mı?

3.

a. **HighSyn-HighPhono, ENC:** *İşinde acemi* çırakları**n** boyacıları**n** satıcı**nın** yeni müdüre gösterdiği mobilyaya sürdükleri boyayı *dikkatsiz şekilde* döktüklerini zannettim. Yazık olurdu.

b. **LowSyn-HighPhono, ENC:** *İşinde acemi* çıraklar boyacıları**n** satıcı**nın** mağaza**nın** müdürüne gösterdiği mobilyaya sürdükleri boyayı *dikkatsiz şekilde* döktüler zannettim. Yazık olurdu.

c. **LowSyn-LowPhono, ENC:** *İşinde acemi* çıraklar boyacıları**n** satıcı**nın** yeni müdüre gösterdiği mobilyaya sürdükleri boyayı *dikkatsiz şekilde* döktüler zannettim. Yazık olurdu.
'I thought that the *inexperienced* apprentices *carelessly* spilled the paint that the painters applied to the furniture that the salesperson showed to the new manager/ store manager. That would be a pity.'

d. **HighSyn-HighPhono, DISC:** Çırakları**n** boyacıları**n** satıcı**nın** *takım elbiseli* yeni müdüre *dün akşam* gösterdiği mobilyaya sürdükleri boyayı döktüklerini zannettim. Yazık olurdu.

e. **LowSyn-HighPhono, DISC:** Çıraklar boyacıları**n** satıcı**nın** mağaza**nın** *takım elbiseli* müdürüne *dün akşam* gösterdiği mobilyaya sürdükleri boyayı döktüler zannettim. Yazık olurdu.

f. **LowSyn-LowPhono, DISC:** Çıraklar boyacıları**n** satıcı**nın** *takım elbiseli* yeni müdüre *dün akşam* gösterdiği mobilyaya sürdükleri boyayı döktüler zannettim. Yazık olurdu.
'I thought that the apprentices spilled the paint that the painters applied to the furniture that the salesperson *in suit* showed to the new manager/ store's manager *last night*. That would be a pity.'

NP6 :Mobilya gösterildi mi?
NP7 :Boya karıştırıldı mı?

4.

a. **HighSyn-HighPhono, ENC:** *Olaya tekili* velile**rin** öğretmenle**rin** matematikçi**nin** üst kurula gönderdiği öğrenciye verdikleri cezayı *birkaç defa* hatırlattıklarını sandık. Öyle olmalıydı.
b. **LowSyn-HighPhono, ENC:** *Olaya tekili* veliler öğretmenle**rin** matematikçi**nin** okul**un** kuruluna gönderdiği öğrenciye verdikleri cezayı *birkaç defa* hatırlattılar sandık. Öyle olmalıydı.
c. **LowSyn-LowPhono, ENC:** *Olaya tekili* veliler öğretmenle**rin** matematikçi**nin** üst kurula gönderdiği öğrenciye verdikleri cezayı *birkaç defa* hatırlattılar sandık. Öyle olmalıydı.
'We thought that the parents *reacting to the situation* reminded *several times* the punishment that the teachers gave to the student that the math teacher sent to the supreme board/ school's board. That is how it should have been.'
d. **HighSyn-HighPhono, DISC:** Velile**rin** öğretmenle**rin** matematikçi**nin** *oldukça katı* üst kurula *geçen hafta* gönderdiği öğrenciye verdikleri cezayı hatırlattıklarını sandık. Öyle olmalıydı.
e. **LowSyn-HighPhono, DISC:** Veliler öğretmenle**rin** matematikçi**nin** okul**un** *oldukça katı* kuruluna *geçen hafta* gönderdiği öğrenciye verdikleri cezayı hatırlattılar sandık. Öyle olmalıydı.
f. **LowSyn-LowPhono, DISC:** Veliler öğretmenle**rin** matematikçi**nin** *oldukça katı* üst kurula *geçen hafta* gönderdiği öğrenciye verdikleri cezayı hatırlattılar sandık. Öyle olmalıydı.
'We thought that the parents reminded the punishment that the teachers gave to the student that the math teacher sent to the *quite strict* supreme board/ school's board *last week.* That is how it should have been.'

NP6 :Öğrenci uyarıldı mı?
NP7 :Ceza verildi mi?

5.

a. **HighSyn-HighPhono, ENC:** *Güvenlik kılığındaki* hırsızla**rın** yazılımcıla**rın** müdür**ün** yeni ofise aldığı bilgisayara yükledikleri dosyayı *herkesten gizli* kopyaladıklarını zannettik. Bunu beklemiyorduk.
b. **LowSyn-HighPhono, ENC:** *Güvenlik kılığındaki* hırsızlar yazılımcıla**rın** müdür**ün** yönetim**in** ofisine aldığı bilgisayara yükledikleri dosyayı *herkesten gizli* kopyaladılar zannettik. Bunu beklemiyorduk.
c. **LowSyn-LowPhono, ENC:** *Güvenlik kılığındaki* hırsızlar yazılımcıla**rın** müdür**ün** yeni ofise aldığı bilgisayara yükledikleri dosyayı *herkesten gizli* kopyaladılar zannettik. Bunu beklemiyorduk.
'We thought that the thieves *dressed as security secretly* copied the document that the software developers downloaded to the computer that the manager bought for the new office/ administration's office. We did not expect that.'
d. **HighSyn-HighPhono, DISC:** Hırsızla**rın** yazılımcıla**rın** müdür**ün** *üst kattaki* yeni ofise *geçen ay* aldığı bilgisayara yükledikleri dosyayı kopyaladıklarını zannettik. Bunu beklemiyorduk.
e. **LowSyn-HighPhono, DISC:** Hırsızlar yazılımcıla**rın** müdür**ün** yönetim**in** *üst kattaki* ofisine *geçen ay* aldığı bilgisayara yükledikleri dosyayı kopyaladılar zannettik. Bunu beklemiyorduk.

f. **LowSyn-LowPhono, DISC:** Hırsızlar yazılımcıları**n** müdür**ün** *üst kattaki* yeni ofise *geçen ay* aldığı bilgisayara yükledikleri dosyayı kopyaladılar zannettik. Bunu beklemiyorduk.
'We thought that the thieves copied the document that the software developers downloaded to the computer that the manager bought for the new office/ administration's office *upstairs last month*. We did not expect that.'

NP6 :Bilgisayar alındı mı?
NP7 :Dosya silindi mi?

6.

a. **HighSyn-HighPhono, ENC:** *Nöbetçi eczanedeki* eczacıları**n** doktorları**n** hemşire**nin** ilaçlı serumu taktığı hastaya yazdıkları reçeteyi *uzun uzun* açıkladıklarını sandık. Öyle değilmiş.
b. **LowSyn-HighPhono, ENC:** *Nöbetçi eczanedeki* eczacılar doktorları**n** hemşire**nin** hastane**nin** serumunu taktığı hastaya yazdıkları reçeteyi *uzun uzun* açıkladılar sandık. Öyle değilmiş.
c. **LowSyn-LowPhono, ENC:** *Nöbetçi eczanedeki* eczacılar doktorları**n** hemşire**nin** ilaçlı serumu taktığı hastaya yazdıkları reçeteyi *uzun uzun* açıkladılar sandık. Öyle değilmiş.
'I learned that the pharmacists *at the pharmacy on duty* explained *at length* the prescription that the doctors wrote to the patient that the nurse put the medicated IV/ hospital's IV on. Apparently it was not the case.'
d. **HighSyn-HighPhono**, **DISC:** Eczacıları**n** doktorları**n** hemşire**nin** *ağrı kesici* ilaçlı serumu *dün akşam* taktığı hastaya yazdıkları reçeteyi açıkladıklarını sandık. Öyle değilmiş.
e. **LowSyn-HighPhono**, **DISC:** Eczacılar doktorları**n** hemşire**nin** hastane**nin** *aprı kesicili* serumunu *dün akşam* taktığı hastaya yazdıkları reçeteyi açıkladılar sandık. Öyle değilmiş.
f. **LowSyn-LowPhono**, **DISC:** Eczacılar doktorları**n** hemşire**nin** *ağrı kesici* ilaçlı serumu *dün akşam* taktığı hastaya yazdıkları reçeteyi açıkladılar sandık. Öyle değilmiş.
'I learned that the pharmacists explained the prescription that the doctors wrote to the patient that the nurse put the *painkiller* medicated IV/ hospital's IV on *last night*. Apparently it was not the case.'

NP6 :Hasta gönderildi mi?
NP7 :Reçete yazıldı mı?

7.

a. **HighSyn-HighPhono, ENC:** *Mavi üniformalı* hemşireler**in** doktorları**n** hasta**nın** genç eczacıya gösterdiği yaraya önerdikleri merhemi *pamuk yardımıyla* sürdüklerini zannettik. İyi gelirdi.
b. **LowSyn-HighPhono, ENC:** *Mavi üniformalı* hemşireler doktorları**n** hasta**nın** hastane**nin** eczacısına gösterdiği yaraya önerdikleri merhemi *pamuk yardımıyla* sürdüler zannettik. İyi gelirdi.
c. **LowSyn-LowPhono, ENC:** *Mavi üniformalı* hemşireler doktorları**n** hasta**nın** genç eczacıya gösterdiği yaraya önerdikleri merhemi *pamuk yardımıyla* sürdüler zannettik. İyi gelirdi.

'We thought that the nurses *in blue uniform* applied *with cotton* the salve that the doctors recommended for the scar that the patient showed to the young pharmacist/hospital's pharmacist. That would help him feel better.'

d. **HighSyn-HighPhono, DISC:** Hemşireler**in** doktorlar**ın** hasta**nın** *kısa saçlı* genç eczacıya *dün sabah* gösterdiği yaraya önerdikleri merhemi sürdüklerini zannettik. İyi gelirdi.
e. **LowSyn-HighPhono, DISC:** Hemşireler doktorlar**ın** hasta**nın** hastane**nin** *kısa saçlı* eczacısına *dün sabah* gösterdiği yaraya önerdikleri merhemi sürdüler zannettik. İyi gelirdi.
f. **LowSyn-LowPhono, DISC:** Hemşireler doktorlar**ın** hasta**nın** *kısa saçlı* genç eczacıya *dün sabah* gösterdiği yaraya önerdikleri merhemi sürdüler zannettik. İyi gelirdi. That would help him feel better.'
'We thought that the nurses applied the salve that the doctors recommended for the scar that the patient showed to the young pharmacist/ hospital's pharmacist *with short hair yesterday morning*.'

NP6 :Yara iyileştirildi mi?
NP7 :Merhem önerildi mi?

8.

a. **HighSyn-HighPhono, ENC:** *Üniversite öğrencisi* asistanlar**ın** editörler**in** edebiyatçı**nın** ilgili okuyuculara önerdiği siteye yazdıkları makaleyi ***az*** *önce* yüklediklerini sandık. Merakla bekliyorduk.
b. **LowSyn-HighPhono, ENC:** *Üniversite öğrencisi* asistanlar editörler**in** edebiyatçı**nın** dergi**nin** okuyucularına önerdiği siteye yazdıkları makaleyi ***az*** *önce* yüklediler sandık. Merakla bekliyorduk.
c. **LowSyn-LowPhono, ENC:** *Üniversite öğrencisi* asistanlar editörler**in** edebiyatçı**nın** ilgili okuyuculara önerdiği siteye yazdıkları makaleyi ***az*** *önce* yüklediler sandık. Merakla bekliyorduk.
'We thought that the *university student* assistants *just* uploaded the article that the editors wrote for the website that the men of letters recommended to the interested readers/ magazine's readers. We were looking forward to it.'
d. **HighSyn-HighPhono, DISC:** Asistanlar**ın** editörler**in** edebiyatçı**nın** *şiire meraklı* genç okuyuculara *yeni sayıda* önerdiği siteye yazdıkları makaleyi yüklediklerini sandık. Merakla bekliyorduk.
e. **LowSyn-HighPhono, DISC:** Asistanlar editörler**in** edebiyatçı**nın** dergi**nin** *şiire meraklı* okuyucularına *yeni sayıda* önerdiği siteye yazdıkları makaleyi yüklediler sandık. Merakla bekliyorduk.
f. **LowSyn-LowPhono, DISC:** Asistanlar editörler**in** edebiyatçı**nın** *şiire meraklı* genç okuyuculara *yeni sayıda* önerdiği siteye yazdıkları makaleyi yüklediler sandık. Merakla bekliyorduk.
'We thought that the assistants uploaded the article that the editors wrote for the website that the men of letters recommended to the young readers/ magazine's readers *who are into poetry in the new issue*. We were looking forward to it.'

NP6 :Site önerildi mi?
NP7 :Makale silindi mi?

9.

a. **HighSyn-HighPhono, ENC:** *Eli çabuk* terzile**rin** modacıla**rın** menajer**in** saygın yapımcıya tanıttığı mankene tasarladıkları elbiseyi *iki günde* diktiklerini zannettik. Henüz bitmemiş.
b. **LowSyn-HighPhono, ENC:** *Eli çabuk* terziler modacıla**rın** menajer**in** film**in** yapımcısına tanıttığı mankene tasarladıkları elbiseyi *iki günde* diktiler zannettik. Henüz bitmemiş.
c. **LowSyn-LowPhono, ENC:** *Eli çabuk* terziler modacıla**rın** menajer**in** saygın yapımcıya tanıttığı mankene tasarladıkları elbiseyi *iki günde* diktiler zannettik. Henüz bitmemiş.
'We thought that the *fast-working* tailors *in two days* sewed the dress that the stylists designed for the model that the manager introduced to the honorable producer/movie's producer. Apparently it is not over yet.'
d. **HighSyn-HighPhono, DISC:** Terzile**rin** modacıla**rın** menajer**in** *dünyaca ünlü* saygın yapımcıya *yeni ajansta* tanıttığı mankene tasarladıkları elbiseyi diktiklerini zannettik. Henüz bitmemiş.
e. **LowSyn-HighPhono, DISC:** Terziler modacıla**rın** menajer**in** film**in** *dünyaca ünlü* yapımcısına *yeni ajansta* tanıttığı mankene tasarladıkları elbiseyi diktiler zannettik. Henüz bitmemiş.
f. **LowSyn-LowPhono, DISC:** Terziler modacıla**rın** menajer**in** *dünyaca ünlü* saygın yapımcıya *yeni ajansta* tanıttığı mankene tasarladıkları elbiseyi diktiler zannettik. Henüz bitmemiş.
'I remember that the tailors sewed the dress that the stylists designed for the model that the manager introduced to the *world-famous* honorable producer/ movie's producer *in the new agency*. Apparently it is not over yet.'

NP6 :Manken tanıtıldı mı?
NP7 :Elbise lekelendi mi?

10.

a. **HighSyn-HighPhono, ENC:** *Oldukça titiz* eleştirmenler**in** kameramanla**rın** yapımcı**nın** yeni çekimlere çağırdığı yönetmene hazırladıkları klibi *detaylı şekilde* yorumladıklarını sandım. Herkese anlattım.
b. **LowSyn-HighPhono, ENC:** *Oldukça titiz* eleştirmenler kameramanla**rın** yapımcı**nın** dizi**nin** çekimlerine çağırdığı yönetmene hazırladıkları klibi *detaylı şekilde* yorumladılar sandım. Herkese anlattım.
c. **LowSyn-LowPhono, ENC:** *Oldukça titiz* eleştirmenler kameramanla**rın** yapımcı**nın** yeni çekimlere çağırdığı yönetmene hazırladıkları klibi *detaylı şekilde* yorumladılar sandım. Herkese anlattım.
'I thought that the *quite meticulous* critics reviewed *in detail* the video that the cameramen prepared for the director that the producer invited to the new shot/series' shot. I told it to everyone.'
d. **HighSyn-HighPhono, DISC:** Eleştirmenler**in** kameramanla**rın** yapımcı**nın** *bu sezonki* yeni çekimlere *telefon ile* çağırdığı yönetmene hazırladıkları klibi yorumladıklarını sandım. Herkese anlattım.
e. **LowSyn-HighPhono, DISC:** Eleştirmenler kameramanla**rın** yapımcı**nın** dizi**nin** *bu sezonki* çekimlerine *telefon ile* çağırdığı yönetmene hazırladıkları klibi yorumladılar sandım. Herkese anlattım.

f. **LowSyn-LowPhono, DISC:** Eleştirmenler kameramanlar**ın** yapımcı**nın** *bu sezonki* yeni çekimlere *telefon ile* çağırdığı yönetmene hazırladıkları klibi yorumladılar sandım. Herkese anlattım.
'I thought that the critics reviewed the video that the cameramen prepared for the director that the producer invited to the *new season's* series shot/ new shot *on the phone*. I told it to everyone.'

NP6 :Yönetmen kovuldu mu?
NP7 :Klip hazırlandı mı?

11.

a. **HighSyn-HighPhono, ENC:** *Orta yaşlı* savcıları**n** avukatları**n** muhasebeci**nin** yeni belgeleri sunduğu hakime savundukları yolsuzluğu *sakin şekilde* açıkladıklarını zannettik. Bunu bekliyorduk.
b. **LowSyn-HighPhono, ENC:** *Orta yaşlı* savcılar avukatları**n** muhasebeci**nin** sözleşme**nin** belgelerini sunduğu hakime savundukları yolsuzluğu *sakin şekilde* açıkladılar zannettik. Bunu bekliyorduk.
c. **LowSyn-LowPhono, ENC:** *Orta yaşlı* savcılar avukatları**n** muhasebeci**nin** yeni belgeleri sunduğu hakime savundukları yolsuzluğu *sakin şekilde* açıkladılar zannettik. Bunu bekliyorduk.
'We thought that the *middle-aged* prosecutors *calmly* declared the corruption that the attorneys defended to the judge that the accountant presented the new documents/contract' documents to. We were expecting that.'
d. **HighSyn-HighPhono, DISC:** Savcıları**n** avukatları**n** muhasebeci**nin** *ıslak imzalı* yeni belgeleri *dünkü toplantıda* sunduğu hakime savundukları yolsuzluğu açıkladıklarını zannettik. Bunu bekliyorduk.
e. **LowSyn-HighPhono, DISC:** Savcılar avukatları**n** muhasebeci**nin** sözleşme**nin** *ıslak imzalı* belgelerini *dünkü toplantıda* sunduğu hakime savundukları yolsuzluğu açıkladılar zannettik. Bunu bekliyorduk.
f. **LowSyn-LowPhono, DISC:** Savcılar avukatları**n** muhasebeci**nin** *ıslak imzalı* yeni belgeleri *dünkü toplantıda* sunduğu hakime savundukları yolsuzluğu açıkladılar zannettik. Bunu bekliyorduk.
'We thought that the prosecutors declared the corruption that the attorneys defended to the judge that the accountant presented the new documents/ contract's documents *with wet signature* to *in yesterday's meeting*. We were expecting that.'

NP6 :Hakim vuruldu mu?
NP7 :Yolsuzluk savunuldu mu?

12.

a. **HighSyn-HighPhono, ENC:** *Oldukça sabırlı* hostesler**in** güvenlikler**in** pilot**un** sağ çıkışa yönlendirdiği yolcuya yaptıkları uyarıyı *birkaç kez* tekrarladıklarını zannettim. Panik oldum.
b. **LowSyn-HighPhono, ENC:** *Oldukça sabırlı* hostesler güvenlikler**in** pilot**un** uçağ**ın** çıkışına yönlendirdiği yolcuya yaptıkları uyarıyı *birkaç kez* tekrarladılar zannettim. Panik oldum.

c. **LowSyn-LowPhono, ENC:** *Oldukça sabırlı* hostesler güvenlikler**in** pilot**un** sağ çıkışa yönlendirdiği yolcuya yaptıkları uyarıyı *birkaç kez* tekrarladılar zannettim. Panik oldum.
'I thought that the *quite patient* flight attendants repeated *a few times* the warning that the security gave to the passenger that the pilot directed to the emergency exit on the right/plane's exit. I panicked.'

d. **HighSyn-HighPhono, DISC:** Hostesler**in** güvenlikler**in** pilot**un** *kırmızı ışıklı* sağ çıkışa *acil olarak* yönlendirdiği yolcuya yaptıkları uyarıyı tekrarladıklarını zannettim. Panik oldum.

e. **LowSyn-HighPhono, DISC:** Hostesler güvenlikler**in** pilot**un** uçağ**ın** *kırmızı ışıklı* çıkışına *acil olarak* yönlendirdiği yolcuya yaptıkları uyarıyı tekrarladılar zannettim. Panik oldum.

f. **LowSyn-LowPhono, DISC:** Hostesler güvenlikler**in** pilot**un** *kırmızı ışıklı* sağ çıkışa *acil olarak* yönlendirdiği yolcuya yaptıkları uyarıyı tekrarladılar zannettim. Panik oldum.
'I thought that the flight attendants repeated the warning that the security gave to the passenger that the pilot *urgently* directed to the exit on the right/ plane's exit *with red light*. I panicked.'

NP6 :Yolcu yönlendirildi mi?
NP7 :Uyarı yazıldı mı?

13.

a. **HighSyn-HighPhono, ENC:** *Aşırı yorgun* temizlikçiler**in** işletmeciler**in** şoför**ün** yeni servisi gösterdiği turiste ayırdıkları odayı *yavaş yavaş* hazırladıklarını sandım. İyi olurdu.

b. **LowSyn-HighPhono, ENC:** *Aşırı yorgun* temizlikçiler işletmeciler**in** şoför**ün** otel**in** servisini gösterdiği turiste ayırdıkları odayı *yavaş yavaş* hazırladılar sandım. İyi olurdu.

c. **LowSyn-LowPhono, ENC:** *Aşırı yorgun* temizlikçiler işletmeciler**in** şoför**ün** yeni servisi gösterdiği turiste ayırdıkları odayı *yavaş yavaş* hazırladılar sandım. İyi olurdu.
'I thought that the *extremely tired* cleaners *slowly* prepared the room that the managers reserved for the tourist that the driver showed the new shuttle/hotel's shuttle. That would be good.'

d. **HighSyn-HighPhono, DISC:** Temizlikçiler**in** işletmeciler**in** şoför**ün** *geniş kapasiteli* yeni servisi *el işaretiyle* gösterdiği turiste ayırdıkları odayı hazırladıklarını sandım. İyi olurdu.

e. **LowSyn-HighPhono, DISC:** Temizlikçiler işletmeciler**in** şoför**ün** otel**in** *geniş kapasiteli* servisini *el işaretiyle* gösterdiği turiste ayırdıkları odayı hazırladılar sandım. İyi olurdu.

f. **LowSyn-LowPhono, DISC:** Temizlikçiler işletmeciler**in** şoför**ün** *geniş kapasiteli* yeni servisi *el işaretiyle* gösterdiği turiste ayırdıkları odayı hazırladılar sandım. İyi olurdu.
'I thought that the cleaners prepared the room that the managers reserved for the tourist that the driver showed the new shuttle/ hotel's shuttle *with large capacity with a hand sign*. That would be good.'

NP6 :Turist dövüldü mü?
NP7 :Oda ayırıldı mı?

14.

a. **HighSyn-HighPhono, ENC:** *Hayvan dostu* yetkilileri**n** veterinerleri**n** köylü**nün** büyük barınağa getirdiği köpeğe yazdıkları ilacı *komşu ilçeden* ısmarladıklarını sandım. Herkes ilgiliydi.
b. **LowSyn-HighPhono, ENC:** *Hayvan dostu* yetkililer veterinerleri**n** köylü**nün** ilçe**nin** barınağına getirdiği köpeğe yazdıkları ilacı *komşu ilçeden* ısmarladılar sandım. Herkes ilgiliydi.
c. **LowSyn-LowPhono, ENC:** *Hayvan dostu* yetkililer veterinerleri**n** köylü**nün** büyük barınağa getirdiği köpeğe yazdıkları ilacı *komşu ilçeden* ısmarladılar sandım. Herkes ilgiliydi.
‘I thought that the *animal-lover* officials ordered *from the neighbour district* the medicine that the vets prescribed for the dog that the villager brought to the big shelter/district’s shelter. Everyone was interested.’
d. **HighSyn-HighPhono, DISC:** Yetkilileri**n** veterinerleri**n** köylü**nün** *iki katlı* büyük barınağa *otobüs ile* getirdiği köpeğe yazdıkları ilacı ısmarladıklarını sandım. Herkes ilgiliydi.
e. **LowSyn-HighPhono, DISC:** Yetkililer veterinerleri**n** köylü**nün** ilçe**nin** *iki katlı* barınağına *otobüs ile* getirdiği köpeğe yazdıkları ilacı ısmarladılar sandım. Herkes ilgiliydi.
f. **LowSyn-LowPhono, DISC:** Yetkililer veterinerleri**n** köylü**nün** *iki katlı* büyük barınağa *otobüs ile* getirdiği köpeğe yazdıkları ilacı ısmarladılar sandım. Herkes ilgiliydi.
‘I thought that the officials ordered the medicine that the vets prescribed for the dog that the villager brought to the *two-storey* big shelter/ district’s shelter *by bus.* Everyone was interested.’

NP6 :Köpek getirildi mi?
NP7 :İlaç döküldü mü?

15.

a. **HighSyn-HighPhono, ENC:** *Orta yaşlı* hizmetçileri**n** perdeceri**n** bakıcı**nın** demir başlığı taşıdığı odaya diktikleri tülü *temizlik sonrası* astıklarını sandık. Ev tertemizdi.
b. **LowSyn-HighPhono, ENC:** *Orta yaşlı* hizmetçiler perdeceri**n** bakıcı**nın** yatağ**ın** başlığını taşıdığı odaya diktikleri tülü *temizlik sonrası* astılar sandık. Ev tertemizdi.
c. **LowSyn-LowPhono, ENC:** *Orta yaşlı* hizmetçiler perdeceri**n** bakıcı**nın** demir başlığı taşıdığı odaya diktikleri tülü *temizlik sonrası* astılar sandık. Ev tertemizdi.
‘We thought that the *middle-aged* maids hung the tulle curtains that the curtain sellers sewed for the room that the caretaker moved the iron headboard/ bed’s headboard *after cleaning.* The house was super clean.’
d. **HighSyn-HighPhono, DISC:** Hizmetçileri**n** perdeceri**n** bakıcı**nın** *beyaz renkli* demir başlığı *zar zor* taşıdığı odaya diktikleri tülü astıklarını sandık. Ev tertemizdi.
e. **LowSyn-HighPhono, DISC:** Hizmetçiler perdeceri**n** bakıcı**nın** yatağ**ın** *beyaz renkli* başlığını *zar zor* taşıdığı odaya diktikleri tülü astılar sandık. Ev tertemizdi.

f. **LowSyn-LowPhono, DISC:** Hizmetçiler perdeciler**in** bakıcı**nın** *beyaz renkli* demir başlığı *zar zor* taşıdığı odaya diktikleri tülü astılar sandık. Ev tertemizdi.
'We thought that the maids hung the tulle curtains that the curtain sellers sewed for the room that the caretaker moved the *white* headboard/ bed's headboard *with difficulty*. The house was super clean.'

NP6 :Oda temizlendi mi?
NP7 :Tül dikildi mi?

16.

a. **HighSyn-HighPhono, ENC:** *Sokaktaki evsiz* dilenciler**in** çocukları**n** çöpçü**nün** ön kapıya bıraktığı kutuya fırlattıkları oyuncakları *sevinç içinde* topladıklarını zannettik. Ne acıklı.
b. **LowSyn-HighPhono, ENC:** *Sokaktaki evsiz* dilenciler çocukları**n** çöpçü**nün** kapı**nın** önüne bıraktığı kutuya fırlattıkları oyuncakları *sevinç içinde* topladılar zannettik. Ne acıklı.
c. **LowSyn-LowPhono, ENC:** *Sokaktaki evsiz* dilenciler çocukları**n** çöpçü**nün** ön kapıya bıraktığı kutuya fırlattıkları oyuncakları *sevinç içinde* topladılar zannettik. Ne acıklı.
'We thought that the *homeless* beggars *with great joy* collected the toys that the kids threw into the box that the garbageman left at the frontdoor/doorstep. Very sad.'
d. **HighSyn-HighPhono, DISC:** Dilenciler**in** çocukları**n** çöpçü**nün** *mermer taşlı* ön kapıya *temizlik sonrası* bıraktığı kutuya fırlattıkları otuncakları topladıklarını zannettik. Ne acıklı.
e. **LowSyn-HighPhono, DISC:** Dilenciler çocukları**n** çöpçü**nün** apartma**nın** *mermer taşlı* kapısına *temizlik sonrası* bıraktığı kutuya fırlattıkları oyuncakları topladılar zannettik. Ne acıklı.
f. **LowSyn-LowPhono, DISC:** Dilenciler çocukları**n** çöpçü**nün** *mermer taşlı* ön kapıya *temizlik sonrası* bıraktığı kutuya fırlattıkları oyuncakları topladılar zannettik. Ne acıklı.
'We thought that the beggars collected the toys that the kids threw into the box that the garbageman left at the *marble* frontdoor/ apartment's door *after cleaning.* Very sad.'

NP6 :Kutu kırıldı mı?
NP7 :Oyuncaklar fırlatıldı mı?

17.

a. **HighSyn-HighPhono, ENC:** *Eli çabuk* aranjörler**in** besteciler**in** organizatör**ün** dünkü görüşmelere çağırdığı şarkıcıya verdikleri besteyi *bir günde* düzenlediklerini sandım. Öyle söylüyorlardı.
b. **LowSyn-HighPhono, ENC:** *Eli çabuk* aranjörler besteciler**in** organizatör**ün** şirket**in** görüşmelerine çağırdığı şarkıcıya verdikleri besteyi *bir günde* düzenlediler sandım. Öyle söylüyorlardı.
c. **LowSyn-LowPhono, ENC:** *Eli çabuk* aranjörler besteciler**in** organizatör**ün** dünkü görüşmelere çağırdığı şarkıcıya verdikleri besteyi *bir günde* düzenlediler sandım. Öyle söylüyorlardı.

'I thought that the *fast-working* arrangers *in one day* arranged the composition that the composers gave to the singer that the promoter invited to yesterday's meeting/company' meeting. That is what they were saying.'

d. **HighSyn-HighPhono, DISC:** Aranjörler**in** besteciler**in** organizatör**ün** *genel merkezdeki* dünkü görüşmelere *özel olarak* çağırdığı şarkıcıya verdikleri besteyi düzenlediklerini sandım. Öyle söylüyorlardı.
e. **LowSyn-HighPhono, DISC:** Aranjörler besteciler**in** organizatör**ün** şirket**in** *genel merkezdeki* görüşmelerine *özel olarak* çağırdığı şarkıcıya verdikleri besteyi düzenlediler sandım. Öyle söylüyorlardı.
f. **LowSyn-LowPhono, DISC:** Aranjörler besteciler**in** organizatör**ün** *genel merkezdeki* dünkü görüşmelere *özel olarak* çağırdığı şarkıcıya verdikleri besteyi düzenlediler sandım. Öyle söylüyorlardı.
'I thought that the arrangers arranged the composition that the composers gave to the singer that the promoter invited to the yesterday's meetings/ company's meetings *at the head office privately*. That is what they were saying.'

NP6 :Şarkıcı çağırıldı mı?
NP7 :Beste kaydedildi mi?

18.

a. **HighSyn-HighPhono, ENC:** *Okuldaki yeni* öğretmenler**in** sanatçıları**n** müdür**ün** diğer kuruma bildirdiği öğrencilere gönderdikleri hediyeleri *birer birer* paylaştırdıklarını sandık. İyi olurdu.
b. **LowSyn-HighPhono, ENC:** *Okuldaki yeni* öğretmenler sanatçıları**n** müdür**ün** belediye**nin** kurumuna bildirdiği öğrencilere gönderdikleri hediyeleri *birer birer* paylaştırdılar sandık. İyi olurdu.
c. **LowSyn-LowPhono, ENC:** *Okuldaki yeni* öğretmenler sanatçıları**n** müdür**ün** diğer kuruma bildirdiği öğrencilere gönderdikleri hediyeleri *birer birer* paylaştırdılar sandık. İyi olurdu.
'We thought that the *new* teachers *at school one by one* alloted the presents that the artists sent to the students that the principal reported to the other organization/municipality's organization. That would be good.'
d. **HighSyn-HighPhono, DISC:** Öğretmenler**in** sanatçıları**n** müdür**ün** *eğitim odaklı* diğer kuruma *dilekçe ile* bildirdiği öğrencilere gönderdikleri hediyeleri paylaştırdıklarını sandık. İyi olurdu.
e. **LowSyn-HighPhono, DISC:** Öğretmenler sanatçıları**n** müdür**ün** belediye**nin** *eğitim odaklı* kurumuna *dilekçe ile* bildirdiği öğrencilere gönderdikleri hediyeleri paylaştırdılar sandık. İyi olurdu.
f. **LowSyn-LowPhono, DISC:** Öğretmenler sanatçıları**n** müdür**ün** *eğitim odaklı* diğer kuruma *dilekçe ile* bildirdiği öğrencilere gönderdikleri hediyeleri paylaştırdılar sandık. İyi olurdu.
'We thought that the teachers alloted the presents that the artists sent to the students that the principal reported to the other *education-focused* organization/ municipality's organization *with petition*. That would be good.'

NP6 :Öğrenciler arandı mı?
NP7 :Hediyeler gönderildi mi?

19.

a. **HighSyn-HighPhono, ENC:** *Deneyden sorumlu* asistanları**n** kimyagerler**in** laborantı**n** genç stajyere temizlettiği tüpe doldurdukları karışımı *az önce* döktüklerini zannettim. Kötü olurdu.
b. **LowSyn-HighPhono, ENC:** *Deneyden sorumlu* asistanlar kimyagerler**in** laborantı**n** kliniğ**in** stajyerine temizlettiği tüpe doldurdukları karışımı *az önce* döktüler zannettim. Kötü olurdu.
c. **LowSyn-LowPhono, ENC:** *Deneyden sorumlu* asistanlar kimyagerler**in** laborantı**n** genç stajyere temizlettiği tüpe doldurdukları karışımı *az önce* döktüler zannettim. Kötü olurdu.
'I thought that the assistants *responsible for the experiment just* spilled the mixture that the chemists filled the tube with that the laborant made the young intern/ clinic's intern clean. That would be bad.'
d. **HighSyn-HighPhono, DISC:** Asistanları**n** kimyagerler**in** laborantı**n** *deneyden sorumlu* genç stajyere *zar zor* temizlettiği tüpe doldurdukları karışımı döktüklerini zannettim. Kötü olurdu.
e. **LowSyn-HighPhono, DISC:** Asistanlar kimyagerler**in** laborantı**n** kliniğ**in** *deneyden sorumlu* stajyerine *zar zor* temizlettiği tüpe doldurdukları karışımı döktüler zannettim. Kötü olurdu.
f. **LowSyn-LowPhono, DISC:** Asistanlar kimyagerler**in** laborantı**n** *deneyden sorumlu* genç stajyere *zar zor* temizlettiği tüpe doldurdukları karışımı döktükler zannettim. Kötü olurdu.
'I thought that the assistants spilled the mixture with which the chemists filled the tube that the laborant made the young trainee/ clinic's trainee *responsible for the experiment* clean *with difficulty*. That would be bad.'

NP6 :Tüp temizletildi mi?
NP7 :Karışım verildi mi?

20.

a. **HighSyn-HighPhono, ENC:** *Olay yerindeki* sunucuları**n** muhabirler**in** polis**in** merkez karakola götürdüğü tanığa sordukları soruları *canlı yayında* aktardıklarını zannettim. Öyle diyorlardı.
b. **LowSyn-HighPhono, ENC:** *Olay yerindeki* sunucular muhabirler**in** polis**in** ilçe**nin** karakoluna götürdüğü tanığa sordukları soruları *canlı yayında* aktardılar zannettim. Öyle diyorlardı.
c. **LowSyn-LowPhono, ENC:** *Olay yerindeki* sunucular muhabirler**in** polis**in** merkez karakola götürdüğü tanığa sordukları soruları *canlı yayında* aktardılar zannettim. Öyle diyorlardı.
'I thought that the presenters *at the scene* shared *on live broadcast* the questions that the reporters asked the witness that the policeman took to the central police station/district's police station. That is what they were saying.'
d. **HighSyn-HighPhono, DISC:** Sunucuları**n** muhabirler**in** polis**in** *şehir merkezindeki* büyük karakola *polis arabasında* götürdüğü tanığa sordukları soruları aktardıklarını zannettim. Öyle diyorlardı.
e. **LowSyn-HighPhono, DISC:** Sunucular muhabirler**in** polis**in** ilçe**nin** *şehir merkezindeki* karakoluna *polis arabasında* götürdüğü tanığa sordukları soruları aktardılar zannettim. Öyle diyorlardı.

f. **LowSyn-LowPhono, DISC:** Sunucular muhabirler**in** polis**in** *şehir merkezindeki* büyük karakola *polis arabasında* götürdüğü tanığa sordukları soruları aktardılar zannettim. Öyle diyorlardı.
‘I thought that the presenters shared the questions that the reporters asked the witness that the policeman took to the big police station/ district’s police station *at the city centre in police car*. That is what they were saying.’

NP6 :Tanık götürüldü mü?
NP7 :Sorular okundu mu?

21.

a. **HighSyn-HighPhono, ENC:** *Etik kuruldaki* dekanlar**ın** akademisyenler**in** araştırmacı**nın** uzun raporu gönderdiği birime önerdikleri çözümü *üniversite bülteninde* duyurduklarını sandım. Bunu bekliyorduk.
b. **LowSyn-HighPhono, ENC:** *Etik kuruldaki* dekanlar akademisyenler**in** araştırmacı**nın** proje**nin** raporunu gönderdiği birime önerdikleri çözümü *üniversite bülteninde* duyurdular sandım. Bunu bekliyorduk.
c. **LowSyn-LowPhono, ENC:** *Etik kuruldaki* dekanlar akademisyenler**in** araştırmacı**nın** uzun raporu gönderdiği birime önerdikleri çözümü *üniversite bülteninde* duyurdular sandım. Bunu bekliyorduk.
‘I thought that the deans *at the ethiccal committee* announced *at the university bulletin* the solution that the academics proposed to the unit that the researcher sent the long report/project’s report. We were expecting that.’
d. **HighSyn-HighPhono, DISC:** Dekanlar**ın** akademisyenler**in** araştırmacı**nın** *yirmi sayfalık* uzun raporu *posta yoluyla* gönderdiği birime önerdikleri çözümü duyurduklarını sandım. Bunu bekliyorduk.
e. **LowSyn-HighPhono, DISC:** Dekanlar akademisyenler**in** araştırmacı**nın** proje**nin** *yirmi sayfalık* raporunu *posta yoluyla* gönderdiği birime önerdikleri çözümü duyurdular sandım. Bunu bekliyorduk.
f. **LowSyn-LowPhono, DISC:** Dekanlar akademisyenler**in** araştırmacı**nın** *yirmi sayfalık* uzun raporu *posta yoluyla* gönderdiği birime önerdikleri çözümü duyurdular sandım. Bunu bekliyorduk.
‘I thought that the deans announced the solution that the academics proposed to the unit that the researcher sent the *twenty-page* new report/ project’s report *by post.* We were expecting that.’

NP6 :Birim uyarıldı mı?
NP7 :Çözüm önerildi mi?

22.

a. **HighSyn-HighPhono, ENC:** *Üstün yetenekli* gitaristler**in** besteciler**in** şef**in** yeni orkestraya aldığı müzisyene bahsettikleri şarkıyı *ahenk içinde* çaldıklarını zannettik. Herkes beğenmişti.
b. **LowSyn-HighPhono, ENC:** *Üstün yetenekli* gitaristler besteciler**in** şef**in** kulüb**ün** orkestrasına aldığı müzisyene bahsettikleri şarkıyı *ahenk içinde* çaldılar zannettik. Herkes beğenmişti.
c. **LowSyn-LowPhono, ENC:** *Üstün yetenekli* gitaristler besteciler**in** şef**in** yeni orkestraya aldığı müzisyene bahsettikleri şarkıyı *ahenk içinde* çaldılar zannettik. Herkes beğenmişti.

'We thought that the *gifted* gitarists played *in harmony* the song that the composers mentioned to the musician that the conductor let in the new orchestra/club's orchestra. Everyone liked it.'

d. **HighSyn-HighPhono, DISC:** Gitaristler**in** besteciler**in** şef**in** *konser grubundaki* yeni orkestraya *geçen ay* aldığı müzisyene bahsettikleri şarkıyı çaldıklarını zannettik. Herkes beğenmişti.
e. **LowSyn-HighPhono, DISC:** Gitaristler besteciler**in** şef**in** kulüb**ün** *konser grubundaki* orkestrasına *geçen ay* aldığı müzisyene bahsettikleri şarkıyı çaldılar zannettik. Herkes beğenmişti.
f. **LowSyn-LowPhono, DISC:** Gitaristler besteciler**in** şef**in** *konser grubundaki* yeni orkestraya *geçen ay* aldığı müzisyene bahsettikleri şarkıyı çaldılar zannettik. Herkes beğenmişti.
'We thought that the gitarists played the song that the composers mentioned to the musician that the conductor let in the new orchestra/ club's orchestra *in the concert group last month.* Everyone liked it.'

NP6 :Müzisyen alındı mı?
NP7 :Şarkı söylendi mi?

23.

a. **HighSyn-HighPhono, ENC:** *Temizlikten sorumlu* kapıcıları**n** kiracıları**n** çevreci**nin** arka bahçeye koyduğu kutuya attıkları çöpü *gece yarısı* boşalttıklarını sandım. Komşudan duydum.
b. **LowSyn-HighPhono, ENC:** *Temizlikten sorumlu* kapıcılar kiracıları**n** çevreci**nin** apartma**nın** bahçesine koyduğu kutuya attıkları çöpü *gece yarısı* boşalttılar sandım. Komşudan duydum.
c. **LowSyn-LowPhono, ENC:** *Temizlikten sorumlu* kapıcılar kiracıları**n** çevreci**nin** arka bahçeye koyduğu kutuya attıkları çöpü *gece yarısı* boşalttılar sandım. Komşudan duydum.
'I thought that the doormen *responsible for cleaning* discharged *in the middle of the night* the trash that the tenants threw into the box that the environmentalist put in the backyard/ apartment's yard. I heard it from the neighbour.'
d. **HighSyn-HighPhono, DISC:** Kapıcıları**n** kiracıları**n** çevreci**nin** *dağınık haldeki* arka bahçeye *dün gece* koyduğu kutuya attıkları çöpü boşalttıklarını sandım. Komşudan duydum.
e. **LowSyn-HighPhono, DISC:** Kapıcılar kiracıları**n** çevreci**nin** apartma**nın** *dağınık haldeki* bahçesine *dün gece* koyduğu kutuya attıkları çöpü boşalttılar sandım. Komşudan duydum.
f. **LowSyn-LowPhono, DISC:** Kapıcılar kiracıları**n** çevreci**nin** *dağınık haldeki* arka bahçeye *dün gece* koyduğu kutuya attıkları çöpü boşalttılar sandım. Komşudan duydum.
'I thought that the doormen discharged the trash that the tenants threw into the box that the environmentalist put in the *messy* backyard/ apartment's yard *last night.* I heard it from the neighbour.'

NP6 :Kutu koyuldu mu?
NP7 :Çöp karıştırıldı mı?

24.

a. **HighSyn-HighPhono, ENC:** *İlçedeki uzman* rehberler**in** tarihçiler**in** ressa**mın** yüklü geliri bağışladığı öğrencilere anlattıkları harabeleri *grup halinde* gezdirdiklerini zannettim. Herkes eğlenmişti.
b. **LowSyn-HighPhono, ENC:** *İlçedeki uzman* rehberler tarihçiler**in** ressa**mın** sergi**nin** gelirini bağışladığı öğrencilere anlattıkları harabeleri *grup halinde* gezdirdiler zannettim. Herkes eğlenmişti.
c. **LowSyn-LowPhono, ENC:** *İlçedeki uzman* rehberler tarihçiler**in** ressa**mın** yüklü geliri bağışladığı öğrencilere anlattıkları harabeleri *grup halinde* gezdirdiler zannettim. Herkes eğlenmişti.
'I thought that the *expert* tour guides *at the county* showed *as a group* the ruins that the history teachers told the students that the painter donated the huge income/exhibition's income. Everybody had fun.'
d. **HighSyn-HighPhono, DISC:** Rehberler**in** tarihçiler**in** ressam**ın** *bağış fonundaki* yüklü geliri *gönüllü olarak* bağışladığı öğrencilere anlattıkları harabeleri gezdirdiklerini zannettim. Herkes eğlenmişti.
e. **LowSyn-HighPhono, DISC:** Rehberler tarihçiler**in** ressam**ın** sergi**nin** *bağış fonundaki* gelirini *gönüllü olarak* bağışladığı öğrencilere anlattıkları harabeleri gezdirdiler zannettim. Herkes eğlenmişti.
f. **LowSyn-LowPhono, DISC:** Rehberler tarihçiler**in** ressam**ın** *bağış fonundaki* yüklü geliri *gönüllü olarak* bağışladığı öğrencilere anlattıkları harabeleri gezdirdiler zannettim. Herkes eğlenmişti.
'I thought that the tour guides showed the ruins that the history teachers told the students that the painter donated the huge income/ exhibition's income *in the endowment fund voluntarily*. Everybody had fun.'

NP6 :Öğrenciler cezalandırıldı mı?
NP7 :Harabeler anlatıldı mı?

APPENDIX H

EXPERIMENT 3: FILLER ITEMS AND COMPREHENSION QUESTIONS

Related fillers with two levels of embedding:

1. Müdürün öğrencilerin yurda misafir getirmelerine izin vermemesinin sebebinin geçen yıl yaşanan üzücü olaylar olduğunu sandım. Küçük olaylarmış.

Misafire izin verilmiş mi?

2. Mühendisin şantiyede iş kazası geçirip yaralanan genç işçinin ağır yaralı olarak hastaneye kaldırıldığını bildiğini zannettim. Kimse söylememiş.

Mühendis hastaneye kaldırılmış?

3. Müşteri tecrübeli satıcının aylardır mağazada bekleyen ürünü satmak için söyledikleri üzerine ürünü satın almış zannettim. Meğer vazgeçmiş.

Ürün satılmış mı?

4. Antrenör müsabakalara oldukça sıkı hazırlanan üstün yetenekli sporcunun geçen gün doping testini geçemediğine şaşırdı sandım. Zaten biliyormuş.

Test geçilmiş mi?

5. Bankacı kredi çekmek için gelen müşterinin mal varlığının yeterli olmadığını öne sürerek talebi reddetti sandım. Sonuç bekleniyormuş.

Talep reddedilmiş mi?

6. Coşkulu izleyicinin performans sonunda dakikalar boyunca alkışladığı ünlü müzisyenin bu konserde sahnelere veda ettiğini zannettim. Henüz değilmiş.

Müzisyen alkışlanmış mı?

7. Tüm müşteriler son üç yıldır markette çalışan kasiyerin sürekli yanlış hesap yapmasından şikayetçi oldular zannettim. Önem vermiyorlarmış.

Yanlış hesap yapılmış mı?

8. Okuldaki kırtasiyecinin dönem başında oldukça pahalıya sattığı sert kapaklı defterlerin dönem ortasına doğru ucuzladığını zannettim. Hala pahalı.

Defterler ucuzlamış mı?

9. Ebeveynler bakkalın dükkanı yeni sağlıksız abur cubur ürünlerle doldurması üzerine çocukların sağlığı için endişelendi zannettim. Fiyatlardan şikayetçilermiş.

Fiyatlardan şikayet edilmiş mi?

10. Yayıncının yeni çıkan kitapların çevirisi için sözleşme imzaladığı genç çevirmenin işinde oldukça iyi olduğunu sandım. Tecrübeli değilmiş.

Sözleşme imzalanmış mı?

11. Okula yeni gelen fizikçi dersi dinlemeyen öğrencilerin sınavdan kötü not alacaklarını önceden tahmin etmiştir sandım. Sonuçlara şaşırmış.

Sonuçlara şaşırılmış mı?

12. Yan komşuların düzenli olarak gazete okumayan orta yaşlı kahvecinin oldukça cahil biri olduğunu düşündüklerini sandım. Öyle değilmiş.

Gazete okunmuş mu?

Unrelated fillers:

1. İtfaiye yangını söndürmek için tonlarca su harcamasına rağmen ormanın çok büyük bir bölümü maalesef yandı. Yazık oldu.

Su harcanmış mı?

2. Oldukça genç görünen şirket yöneticisinin formunu korumak için düzenli olarak her gün spor yaptığını duydum. Ne güzel.

Şirket kurulmuş mu?

3. Uzmanlar üniversite sınavına hazırlanan stresli lise öğrencilerine biraz rahatlamaları için çeşitli sosyal aktivitelere katılmalarını önerdi. Faydalı olacaktır.

Aktiviteler önerilmiş mi?

4. Veteriner arka sokakta köpekler tarafından saldırıya uğrayan yavru kediyi saatlerdir hareketsiz durduğu için öldü sanmış. Ağır yaralıymış.

Kediye saldırılmış mı?

5. Tüm veliler bayram töreninde ezberden şiir okuyan ikinci sınıf öğrencisi çocuğun sahne heyecanını anlayışla karşıladı. Güzel törendi.

Çocuğa bağırılmış mı?

6. Hırslı patron şirketin sosyal medya hesabının takipçi sayısı iki katına çıktı diye herkese ikramiye vermiş. Ne cömert.

İkramiye verildi mi?

7. Oldukça sabırlı kuaför dükkana yeni aldığı deneyimsiz çırağın müşterilerle sıkça tartışmasına hiç ses çıkarmıyor galiba. Çok rahat.

Çırak kovulmuş mu?

8. Ofisteki herkes geçen hafta başında toplantı düzenleyen genç mağaza müdürünü acemi tavırları yüzünden stajyer zannetmiş. Kötü olmuş.

Toplantı düzenlenmiş mi?

9. Dün gece sabaha karşı komşunun evine camdan giren maskeli hırsızın çaldığı mücevherler milyon dolar değerindeymiş. Hırsız kaçmış.

Mücevherler bulunmuş mu?

10. Psikoloğun işten kovulduğu için ağır bir depresyon geçiren hastasına uyguladığı konuşma terapi çok işe yarıyormuş. Çok iyi.

Psikolog gönderilmiş mi?

11. Annemler misafirlerin yemeğe gelirken getirdikleri kırmızı etiketli şarabın eski bir Fransız şarabı olduğunu hiç anlamamışlar. Bunu beklemezdim.

Şarap içilmiş mi?

12. Ameliyatı başarılı geçince uzun bir aradan sonra sahalara geri dönen futbolcu maçta üç gol atmış. Herkes sevinçli.

Gol atılmış mı?

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