

THE ROLE OF HEURISTICS IN SENTENCE PROCESSING IN TURKISH

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THE ROLE OF HEURISTICS IN SENTENCE PROCESSING IN TURKISH

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## DECLARATION OF ORIGINALITY

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## ABSTRACT

### The Role of Heuristics in Sentence Comprehension

One of the main research areas in psycholinguistic focuses on how people understand sentences. In sentence comprehension studies, it has been shown that language users sometimes engage in ‘shallow’ processing (Barton & Sanford, 1993; Ferreira, 2003), that non-canonical sentences are often misinterpreted (Ferreira, 2003), that misinterpretations during online comprehension are due to incomplete reanalysis (Christianson et al., 2001). These findings have given way to the Good-Enough processing approach (Ferreira, 2003; Ferreira, Bailey & Ferraro, 2002; Ferreira & Patson, 2007; Sanford & Sturt, 2002; Swets, Desmet, Clifton & Ferreira, 2008; Townsend & Bever, 2001). In this approach, it is assumed that the sentence comprehension system can develop parsing strategies that are called “heuristics” and make us of these “shortcuts” (Swets et al., 2008). At the center of the present study lies the role of heuristics based on animacy in processing sentences. To test this, Turkish sentences including a local ambiguity are used in this study. Results of a self-paced reading experiment show that people may treat the same ambiguous sequence differently based on the animacy of the noun phrases that make up the sequence. In addition, the disambiguation of the locally ambiguous sequence may also be affected by the animacy of the noun phrases in the sequence.

## ÖZET

### Cümle Anlamada Sezgisellerin Rolü

Psikodilbilim içindeki araştırma alanlarından biri insanların cümleleri nasıl anladığına odaklanır. Cümle anlama çalışmalarında gösterilmiştir ki dil kullanıcıları cümleleri bazen ‘yüzeysel’ bir şekilde işlemlemektedir (Barton & Sanford, 1993; Ferreira, 2003), standart dışı cümleler sık sık yanlış anlaşılmaktadır (Ferreira, 2003), çevrimiçi cümle anlamadaki yanlış anlamalar eksik yeniden-çözümlemeden ötürüdür (Christianson et al., 2001). Bu bulgular Yeterince-İyi (Ferreira, 2003; Ferreira, Bailey & Ferraro, 2002; Ferreira & Patson, 2007; Sanford & Sturt, 2002; Swets, Desmet, Clifton & Ferreira, 2008; Townsend & Bever, 2001) işleme yaklaşımına öncü olmuştur. Bu yaklaşımda, cümle anlama sisteminin “sezgisel” olarak adlandırılan stratejiler geliştirebildiği ve bu kısayolları (Swets et al., 2008) kullandığı varsayılmaktadır. Bu çalışmanın merkezinde adların canlı olma özellikleri üzerinden geliştirilen sezgiselin cümle işlemelemedeki rolü vardır. Bunu test etmek için, bölgesel olarak iki anlamlı olan yapılar içeren cümleler kullanılmaktadır. Kendi-hızında okuma deneyinin sonuçları göstermektedir ki insanlar aynı iki anlamlı yapıya, yapıyı oluşturan adların canlılık özelliğine göre farklı şekilde davranabilmektedir. Ayrıca, bölgesel olarak iki anlamlı olan yapının netleştirilmesi de ad dizisindeki adların canlılık özelliklerinden etkilenebilmektedir.

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## ABBREVIATIONS

ACC	accusative
ABL	ablative
ADJ	adjective
AI	animate-inanimate
AOR	aorist
COP	copula
ERP	event-related potentials
EV	evidential
GEN	genitive
LE	linking element
LOC	locative
IA	inanimate-animate
M	mean
ms	millisecond
NEG	negation
NP	noun phrase
OBLG	obligation
PASS	passive
PF	perfective
PL	plural
POSS	possessive
PSB	possibility
PST	past tense

RSVP	rapid serial visual presentation
RT	reading time
SG	singular

# CHAPTER 1

## INTRODUCTION

Speakers of any given language must deal with linguistic input to understand language and to communicate, which takes place in a very short period of time because syntactic parsing is considered to be rapid and incremental (Marslen-Wilson, 1973; 1975). Psycholinguistic studies attempt to answer not only the question of how language users process language but also the question of how they do that so quickly.

The attempt to answer this research question, in fact, includes the question of whether native speakers make use of certain cues to ease the difficulty they might experience in processing a locally ambiguous sequence of words. In the framework called Good-Enough Processing (Ferreira, 2003; Ferreira, Bailey & Ferraro, 2002; Ferreira & Patson, 2007; Sanford & Sturt, 2002; Swets, Desmet, Clifton, & Ferreira, 2008; Townsend & Bever, 2001), it is claimed that the parser does not fully process syntactic structures, rather it generates an incomplete representation of the structure such that it makes sense of it at the soonest time possible. In other words, the parser creates representations that are found adequate by the comprehender, i.e. good-enough, to understand sentences. It is assumed in this approach that the comprehender may make use of cues that should speed up the comprehension process. Those cues, which are often referred to as “heuristics”, will be examined in the context of ambiguity resolution in Turkish.

### 1.1 The aim of the study

The aim of the current study is to find out how parsing heuristics influence dependency resolution in online sentence processing. An example of parsing

strategies that can be considered a heuristic is the canonical sentoid strategy (Bever, 1970). This strategy postulates that speakers of English decide the grammatical roles of the components of a sentence by mapping the syntactic categories of those components onto the word order of English (subject-verb-object).

In the present study, I ask the question of whether a heuristic is used in disambiguating locally ambiguous structures. More specifically, I investigate whether the animacy properties of noun phrases in a locally ambiguous string bias the comprehender towards one of the two potential interpretations of the locally ambiguous string although that information does not provide necessarily reliable information. To this end, I compare the cases where the animacy information of two noun phrases in a locally ambiguous string may bias the comprehender towards an interpretation that conflicts the correct interpretation suggested by a disambiguator (e.g. a verb) between the cases where they do not conflict.

## 1.2 The scope of the study

At the center of the present study lies the role of heuristics in processing sentences. To test this, Turkish sentences including a specific kind of local ambiguity are used in this study. The local ambiguity in those sentences stems from the homophony of the accusative case marker and a nominal compound marker in Turkish. A heuristic where the parser determines the semantic role of a noun phrase based on the animacy of that noun in the sentence can make the language comprehension system resolve local ambiguities before a linguistic unit (for example, a verb) appears. However, if the system uses some heuristics and ends up having an interpretation that turns out to be incorrect upon processing the disambiguating region, the comprehender should experience an effect similar to the garden-path effect as the language comprehension

system will need to review the initial interpretation and come up with the correct analysis. Garden-path sentences are widely used in psycholinguistic research (i.a. Christianson, Hollingworth & Halliwell, 2001; Ferreira & Bailey, & Ferraro, 2002; Ferreira, Christianson, Hollingworth, 2001; Ferreira & Henderson, 1991; Fodor & Inoue, 1994; Lau & Ferreira, 2005; Slattery, Sturt, Christianson, Yoshida, & Ferreira, 2013; Tabor & Hutchins, 2004) because these sentences force the comprehender to revisit their interpretation of a sentence through the reanalysis of the sentence structure, which enables us to observe the comprehender's linguistic behavior and test the strategies used in parsing (i.a. Hickok, 1993; Meng & Bader, 2000). Although syntactic parsing is not a process that can be directly observed or measured, psycholinguists often make use of experimental methods including self-paced reading, eye-tracking, speeded acceptability judgments. By using these methods, unobservable processes are turned into observable, measurable units (e.g. reading times, eye movements, acceptability judgments, accuracy in question answering). Looking at such data, we can measure the comprehender's parsing preference since they need to resolve the structural ambiguity in a garden-path sentence in some way. Hence, garden-path sentences may give us an insight into what is happening during online sentence processing (Ferreira & Henderson, 1991). An infamous example of garden-path sentences is given in (1).

(1) The horse raced past the barn fell.

(Bever, 1970)

The sentence in (1) is a garden-path sentence because the comprehender may think that the structure is complete on the word "barn" (due to the minimal attachment principle (Frazier, 1987), which will be discussed in Chapter 3 and Chapter 4 more thoroughly). However, the structure ends in the word "fell". If

the comprehender considers the structure to be complete before it really is, the word “fell” may not be integrated into the structure immediately. Since this is the case for most garden-path sentences, both reading times and difficulty ratings will be collected in the experimental part of the present study.

In Turkish, some suffixes happen to be the same in their phonological form (i.e. they are homophonous). The kind of garden-path that people taking part in this study will deal with is a product of the ambiguity caused by the fact that the marker for the accusative case *-I*, the possessive marker *-(s)I* which also functions as a compound marker can be phonologically identical when the word ends in a consonant. As a matter of fact, these markers are highly productive (Göksel & Kerslake, 2010) and used frequently in the language. However, Turkish does not always phonologically distinguish between these markers, which brings about a type of local ambiguity in sentences as shown in (2).

(2) <i>Misafir</i>	<i>odaları</i>	<i>temiz</i>	<i>birak-ıl-mış</i> (a)
guest	room-PL-ACC/LE	clean	leave-PASS-EV.3

/ *birak-mış-tı* (b).

leave-PF-PST.3

a: ‘The guest rooms were left clean.’

b: ‘The guest left the rooms clean.’

In sentence (2), the sequence *misafir odaları* is locally ambiguous and is disambiguated only on the main verb. A single-argument verb<sup>1</sup> (as in *birakılmış* ‘was left’) brings in a reading where the suffix *-I* on *odaları* ‘rooms’ is a compound marker rather than an accusative marker since *misafir odaları* ‘guest rooms’ cannot be an object and is the only candidate that can be the subject of the sentence. Hence,

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<sup>1</sup> “Single-argument verb” refers to intransitive verbs such as *uyu-* ‘to sleep’ and passivized forms of transitive verbs such as *gör-* ‘to see’.

the compound *misafir odaları* is the subject of the sentence. Contrarily, a two-argument verb<sup>2</sup> (as in *bırakmıştı* ‘left’) yields a reading where the suffix *-I* is an accusative marker, *odaları* is the object of the sentence, and *misafir* is the subject of the sentence. These two seemingly very similar sentences are, then, distinct with regard to their syntactic structures. One of the research questions that the present study is designed to answer is how native speakers of Turkish treat such ambiguities in online processing.

I should acknowledge that local ambiguities originating from phonological coincidences have been used in other studies on Turkish. For example, Dinçtopal-Deniz (2014), and Dinçtopal-Deniz and Fodor (2017) used sentences in Turkish that begin with two noun phrases of which the first one is marked with the genitive case marker (*-In*) and the second one is marked with *-I*, which is ambiguous between the accusative case marker and the possessive marker. The genitive marker in Turkish is used both in genitive-possessive structures such as *şoför-ün oğl-u* (‘the son of the driver’) and on subject-NPs in embedded clauses such as *şoför-ün öldüğünü biliyorum* (‘I know that the driver died.’). In sum, the ambiguity that Dinçtopal-Deniz (2014), and Dinçtopal-Deniz and Fodor (2017) used is due to the dual function of the genitive case marker and the fact that the accusative case marker and the possessive marker can be phonologically identical. Similar to what I use in the present study, they used a verb as the disambiguation region. For instance, a sequence like *öğrenci-nin* (‘the student’) and *psikoloğ-u* (‘the psychologist’) is either a genitive-possessive structure or a subject-object sequence in an embedded clause, which is understood only by a verb that follows the sequence. When the verb is a passive form (i.e. a single-argument verb) like *sevildi* (‘was

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<sup>2</sup> “Two-argument verb” refers to transitive verbs such as *gör-* ‘to see’ and passivized forms of ditransitive verbs such as *ver-* ‘to give’.

liked’), the sequence should be interpreted as a genitive-possessive structure (the psychologist of the student), which is similar to the compound reading I used in the present study. When the verb is an active form that requires an object (i.e. two-argument verb) like *sevdiđini* (‘that [subject] liked [object]’), the sequence should be interpreted as a subject-object sequence, which is the same reading I use in the present study with the exception that the sequences I use do not appear in embeddings.

### 1.3 Organization of the thesis

This chapter’s point was to make a brief introduction before going into the details of the literature and the present study. In the next chapter (Chapter 2), I will describe the local ambiguity that I used to test how ambiguities are treated based on animacy in terms of the relevant linguistic features of the structures with the local ambiguity at issue. Chapter 3 summarizes some of the prominent parsing theories from the literature. Chapter 3 additionally provides a summary and discussion of the finding from the studies that take a ‘good-enough’ stance. Chapter 4 turns to some psycholinguistic approaches to the use of heuristics in sentence comprehension, with a focus on animacy as a feature helping the comprehender develop parsing strategies. Chapter 5 draws the outline of the experiment that I ran in order to measure the potential role of animacy in processing locally ambiguous structures. Chapter 6 presents the results and the relevant findings obtained in the experiment. Chapter 6 also concludes this thesis by looking at the bigger picture based on the implications of the findings.

## CHAPTER 2

### A LOCAL AMBIGUITY IN TWO CONSECUTIVE NOUN PHRASES

#### IN TURKISH

##### 2.1 The source of the ambiguity

For the purposes of this study, sentences in Turkish that involve a local ambiguity are used. The local ambiguity results from the fact that the accusative marker and the compound marker can be homophonous in Turkish, exemplified in (3). A combination of two nouns in Turkish, such as *deve kuşu* denotes two separate entities (i.e. a camel and a bird) or a single entity (an ostrich, if interpreted as a compound). If this combination is interpreted as two separate entities, then the suffix *-u* on the second noun phrase (i.e. *kuş* ‘the bird’) must be taken as the accusative case marker. When *deve kuşu* is interpreted as a single entity, the reading would be a product of taking the two noun phrases to form a compound. Therefore, the suffix *-u* has to be a compound marker, or a linking element (LE) as Göksel and Haznedar (2007) calls it.

- (3)    *deve*            *kuş-u*
- a. camel            bird.ACC        (subject+object)
- b. camel            bird.LE         (compound)

Although the accusative case marker and the nominal compound marker can be homophonous, the ambiguity originating from it is only a local one in a sentence. If we put *deve kuşu* in a sentence, as in (4), the ambiguity will disappear by the time the verb is processed.

- (4a) *Deve*        *kuş-u*            *gör-dü.*
- camel            bird-ACC        see-PST.3SG
- ‘The camel saw the bird.’

(b) *Deve kuş-u uç-a-ma-z.*  
 camel bird-LE fly-PSB-NEG-AOR.3SG

‘Ostriches cannot fly.’

When the verb in the sentence is transitive as in (4a) the comprehender is forced to see the word *deve* as the subject and the word *kuşu* as the object because of the argument requirements of the verb *gördü* ‘saw’. Although the object-drop reading where *deve kuşu* (‘ostrich’) is the subject is possible in the language, it is only licensed by the context. Therefore, the sequence *deve kuşu* in (4a) should be impossible to be seen as the subject. When the verb in the sentence is intransitive as in (4b) the comprehender is forced to take *deve kuşu* as a compound, again because of the argument requirements of the verb *uçamaz* ‘cannot fly’. Therefore, the suffix on *kuşu* (henceforth, *-I*) establishes the relation between the two noun phrases as the accusative marker in (4a) and the compound marker in (4b). The focus of the present study is whether the animacy of the noun phrases in the locally ambiguous word sequence can bias the parser into one of the interpretations, namely the subject+object reading and the compound reading. Since this local ambiguity will be used to ask this research question, it is important to talk about the properties of the accusative case and the compound marker in Turkish, which sometimes happens to be phonologically the same.

## 2.2 The suffix *-I* as the accusative case

The accusative case is one of the nine grammatical cases<sup>3</sup> in Turkish. All of the cases in Turkish are marked through suffixation. Similar to most of the other suffixes in

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<sup>3</sup> The cases in Turkish include nominative, accusative, dative, ablative, genitive, possessive, locative, instrumental, and commitative.

Turkish, the marker of the accusative case “-(y)I”<sup>4</sup> changes its phonological form in accordance with the phonological properties of the word it attaches to, namely, the phonological properties of the last consonant and the vowel in the last syllable.

The accusative case has more than one function. To explain these functions, I will follow the framework of Göksel and Kerslake’s (2010, p. 156-157). The accusative marker is primarily used to show the relation between a noun and a verb that takes this noun as a direct object. The marker is overtly used when the direct object is definite (5).

(5) *Öğretmen-imiz-i gör-dü-k.*

teacher-1PL.POSS-ACC see.PST.1PL

‘We saw our teacher.’

A non-definite (indefinite (6) or categorical (7)) direct object is also marked with the accusative case when it appears in a not immediately preverbal position.

(6) *Birçok şey-i şu dolaba koy-abil-ir-iz.*

a\_lot\_of thing.ACC that cupboard put-PSB-AOR-1PL

‘We can put a lot of things in that cupboard.’ (indefinite)

(7) *Muz-u pastanın içinde hiç*

banana-ACC cake-GEN in-POSS-LOC not\_at\_all

*sev-me-m.*

like-NEG-1SG

‘I hate bananas in my cake.’ (categorical)

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<sup>4</sup> Although this marker is indicated as “-(y)I”, I will not use its forms with the consonant ‘y’ ([j]) for the simple reason that it obligatorily indicates that the suffix is the accusative case marker. That is, structures such that the accusative case is formed only with a vowel will be used so that the ambiguity between the accusative case and the compound marker is maintained.

An indefinite direct object marked with the possessive case that appears in the immediately preverbal position is obligatorily marked with the accusative case (8).

(8) *Bir öğrenci-m-i davet et-ti-m.*

a student-POSS.1SG-ACC invite-PST-1SG

‘I invited a student of mine over.’

However, there is an exception to this rule, where an indefinite direct object is a compound, therefore, it is marked with the third person possessive suffix -(s)I and not marked with the accusative case (9).

(9) *Kahvaltıdan sonra hep bir bitki çayı iç-er-di.*

breakfast-ABL after always a herb tea-LE drink-AOR-PST

‘S/he used to drink a (cup of) herbal tea after breakfast.’

If a direct object refers to plural generic it also has to be marked with the accusative case (10).

(10) *Köpekler-i oldum olası sev-er.*

dog-PL-ACC always love-AOR

‘S/he has always been fond of dogs.’

If a direct object refers to a part of a group of things that are previously mentioned or salient in the discourse it has to be marked with the accusative case (11).

(11) *Çin lokantasından üç erişte söyledik.*

China restaurant-LE-ABL three noodle order-PST-PF

*Bir erişte-yi çok acılı yap-mış-lar.*

One noodle-ACC very spicy make-EV-3PL

‘We ordered three (servings of) noodles from the Chinese restaurant. One (of the) noodle(s) was very spicy.’ (12).

	(12)	<i>Oda-nın</i>	<i>her</i>	<i>yer-i-nde</i>		<i>çiçek-ler</i>
		room-GEN	every	place-POSS-LOC		flower-PL
<i>var-di.</i>		<i>Camın</i>	<i>önündeki</i>	<i>saksı-lar-ı</i>		<i>sev-di-m.</i>
existent-PST		window-GEN	front-LOC-ADJ	pot-PL-ACC		like-PST-1

‘There were flowers all over the room. I liked the flowerpots in front of the window.’

This concludes the discussion of the main syntactic constellations that should have an overt accusative marker. In what follows, I will discuss the relevant linguistics properties of the compound marker *-(s)I* in Turkish.

### 2.3 The suffix *-I* as a compound marker

Since only noun-noun compounds will be used for the purposes of this study, I will not discuss compounding strategies in Turkish other than noun-noun compounds. There are two types of noun-noun compounds in Turkish: bare compounds and *-(s)I* compounds. Bare compounds are constructed by combining two nouns with an overt morphological modification on neither of the nouns. For example, *ahşap* ‘wooden’ and *masa* ‘table’ comes together to form the compound *ahşap masa* ‘wooden table’. *-(s)I* compounds are formed in a similar fashion by which two nouns are combined but with the help of a linking element. This linking element is, as the name implies, the suffix *-(s)I*. For example, *yatak* ‘bed’ and *oda* ‘room’ are combined and the suffix *-(s)I* attaches to *oda*, resulting in *yatak odası* ‘bedroom’. Some examples of both types are given below.

(i) Bare compounds: *ahşap masa* ‘wooden table’, *büyükanne* ‘grandmother’, *hasta bakıcı* ‘nurse’, *güney kampüs* ‘south campus’, *Cami Sokak* ‘Cami Street’.

(ii) *-(s)I* compounds: *süt kaymağ-ı* ‘butterfat’, *yatak oda-sı* ‘bedroom’, *ağz koku-su* ‘jungle mouth’, *hayvan içgüdü-sü* ‘animal instinct’, *güneş krem-i* ‘sunscreen’

I will focus on *-(s)I* compounds as I will not deal with bare compounds in this study. This type of compounds contains at least two nouns and a linking element<sup>5</sup> (*-(s)I*). When an endocentric compound in Turkish consists of two nouns, the first one is the modifier and the second one is the head. However, there are certain N+N compound types where a left headed analysis is plausible (see Göksel & Haznedar (2007) for the discussion of headedness in Turkish compounds). For example, the Turkish equivalent of the compound ‘garlic powder’ has two forms differing in the position of the head: *toz sarımsak* vs. *sarımsak tozu*. The former has a head-final structure which is more common in Turkish while the latter has a head-initial structure as shown in (13).

(13) a. *toz sarımsak*      b. *sarımsak tozu*  
powder      garlic      garlic      powder  
‘garlic powder’

When two nouns are to form an N+N compound, the first noun does not change in form while the second noun is marked with the third person possessive marker (*-(s)I*) which functions as the compound marker (14).

(14) *kutup ayı-sı* ‘polar bear’  
pole      bear-LE

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<sup>5</sup> Göksel & Haznedar (2007) describes linking elements as suffixes that are used in Turkish compounds.

modifier      head

Nevertheless, there are certain compounds where the linking element *-(s)I* is optional as Göksel & Haznedar (2007) discuss. Such compounds include names of some dishes (*kabak dolma-sı* vs. *kabak dolma* ‘stuffed courgette), street names (*Bülbül Sokağ-ı* vs. *Bülbül Sokak*), and some colors (*gök mavi-si* vs. *gök mavi* ‘sky blue’). In these compounds, dropping the linking element does not make any difference. Yet, there are situations where the presence or absence of the linking elements brings in two different meanings as exemplified in (15).

- |         |                |                 |    |                 |               |
|---------|----------------|-----------------|----|-----------------|---------------|
| (15) a. | <i>kadın</i>   | <i>doktor-u</i> | b. | <i>kadın</i>    | <i>doktor</i> |
|         | woman          | doctor-LE       |    | woman           | doctor        |
|         | ‘gynecologist’ |                 |    | ‘female doctor’ |               |

Another morphological property of *-(s)I* is that a stem can have only one *-(s)I* even if the suffix is syntactically and semantically required more than one (Göksel & Haznedar, 2007). For example, when a single stem requires the compound marker twice as it is in an embedded compound structure it can get only one as shown in (16).

- |      |                         |              |                  |                 |
|------|-------------------------|--------------|------------------|-----------------|
| (16) | Polonya                 | <i>gölge</i> | <i>tiyatrosu</i> | ( <i>*-su</i> ) |
|      | Polish                  | shadow       | theatre-LE       |                 |
|      | ‘Polish shadow theatre’ |              |                  |                 |

(Göksel & Haznedar, 2007, p. 17)

[Polonya tiyatrosu] + [gölge tiyatrosu] = Polonya gölge tiyatrosu

In addition to embedded compounds, there is another case where a single stem should have two *-(s)I* but obligatorily has one instead, as shown in (17). Therefore, (b) and (d) are ungrammatical whereas (c) and (e) are grammatical.

- |       |             |                    |            |
|-------|-------------|--------------------|------------|
| (17a) | <i>spor</i> | <i>ayakkabı-sı</i> | ‘sneakers’ |
|-------|-------------|--------------------|------------|

sport		shoe-LE	
(17b)	* <i>benim spor ayakkabı-sı-m</i>		
my	sport	shoe-LE-POSS.1	
(17c)	<i>benim spor ayakkabı-m</i>		‘my sneakers’
my	sport	shoe-POSS.1	
(17d)	* <i>onun spor ayakkabı-sı-sı</i>		
his/her	sport	shoe-LE-POSS.3	
(17e)	<i>onun spor ayakkabı-sı</i>		‘his/her sneakers’
his/her	sport	shoe-POSS.3	

#### 2.4 Adjectival modification

Adjectival modifications in Turkish compounds precede the compound they modify, as illustrated in (18).

(18) a.	<i>mor saç toka-sı</i>	b.	* <i>saç mor toka-sı</i>
purple	hair clip-LE	hair	purple clip-LE
‘purple hair clip’			

The fact that adjectival modifiers cannot intervene between the modifier and the head of a compound indicates that *-(s)I* form a single unit and are inseparable (Göksel & Kerslake, 2005) with a few exceptions<sup>6</sup>.

#### 2.5 The motivation to use the local ambiguity in the present study

The compounding strategy that involves a combination of two nouns and a linking element is highly productive in the language, hence, there are many compounds

<sup>6</sup> Adjectives may occur in between the modifier and the head only if the compound refers to governmental or regulatory authorities or bodies as in *İstanbul Büyükşehir Belediye eski başkanı* ‘former mayor of the metropolitan municipality of Istanbul’. However, Özsoy (2004) points out that this is not productive.

formed with this strategy in Turkish. The plural form of such compounds obtained by combining the nouns then adding the plural marker *-lar* and *-I* (an allomorph of the third-person possessive marker) such as *köpek diş-ler-i* ‘dog teeth’, *kale sur-lar-ı* ‘castle walls’, *su boru-lar-ı* ‘water pipes’. In sum, a very common compounding strategy in Turkish is having two consecutive nouns and a linking element *-(s)I*. However, this operation sometimes creates a particular ambiguity resulting from the fact that the suffix that marks the accusative case *-(y)I* and the third person possessive suffix that serves as a compound marker *-(s)I* can be homophonous, which is phonologically conditioned. With words that end in a vowel, the accusative case marker is *-yI* and the possessive / compound marker is *-sI* (compare *araba-yı* ‘car-ACC’ and *araba-sı* ‘car-POSS.3’). When homophonous they are in the form of one of the allophones of *-I*. In cases where an N+N cluster is marked with *-I*, it is ambiguous between two readings as shown in (19).

(19a) *Çocuk kitab-ı oku-du.*  
 child book-ACC read-PST.3  
 ‘The child read the book.’

(19b) *Çocuk kitab-ı oku-n-du.*  
 child book-LE read-PASS-PST.3  
 ‘The children’s book was read.’

In (19a), *çocuk kitabı* denotes a subject-object string where *çocuk* is the subject and *kitabı* is the object of the sentence. I should also note that there is another possible reading of (19a), where the subject is dropped<sup>7</sup> and *çocuk kitabı* functions as the object of the sentence. In (19b), on the other hand, *çocuk kitabı* denotes a compound where *çocuk* is the modifier and *kitabı* is the head of the

<sup>7</sup> Since Turkish is a pro-drop language, subjects do not always have to be phonologically realized.

compound. This compound functions as the subject of the sentence in (19b). The ambiguity regarding the sequence *çocuk kitabı* is resolved on the verb by means of the theta-role assignment. For example, the verb *okudu* in (19a) assigns the theta-role agent to *çocuk* and the theta-role theme to *kitabı*. In (19b), the verb *okundu* assigns only the theta role theme to *çocuk kitabı* (as a complex NP) since the verb is a passive form. In the end, *çocuk* and *kitabı* are the subject and the object in (19a) respectively, and *çocuk kitabı* is the subject in (19b). Thus, we can say that the transitivity of the verb is crucial in determining the structure of the NP sequence.

Some interesting questions arise at this point of this inquiry: How does the parser process the sentences in (19a) and (19b) - which are almost identical on the surface? These sentences definitely differ from each other with regard to their syntactic structures as explained above. Is reading one of them more difficult than reading the other one? How does the parser deal with the local ambiguity at the beginning of the sentence? Does the parser rely on certain cues (linguistic or non-linguistic cues) to facilitate structure-building in online sentence processing? If the parser develops strategies on the basis of syntactic, semantic, and pragmatic cues, how could it use them? Before attempting to come up with answers, one should talk about how sentences are understood by language users. In what follows, I will provide a brief discussion of some of the prominent accounts of sentence comprehension that are relevant to the present study.

CHAPTER 3  
THEORIES OF SYNTACTIC PARSING  
AND THE ‘GOOD-ENOUGH’ APPROACH

3.1 Prominent theories of sentence comprehension

In psycholinguistics, several accounts have been proposed to explain cognitive mechanisms and mental processes that underlie sentence processing. For example, understanding how syntactic relations called dependencies<sup>8</sup> between words and phrases are resolved is crucial for sentence comprehension research. To this end, researchers try to find out what factors might play a role in dependency resolution. In what follows, I will provide a brief summary of some theories and accounts proposed in the literature, namely, locality accounts, theories that predict anti-locality effects, and content-addressable retrieval model. Then, I will talk about the Good-Enough approach (Ferreira, 2003; Ferreira, Bailey & Ferraro, 2002; Ferreira & Patson, 2007; Sanford & Sturt, 2002; Swets et al., 2008; Townsend & Bever, 2001), which I base my predictions on in the present study.

3.1.1 Locality accounts

One set of prominent accounts in the field, namely the locality accounts (i.a. Gibson, 2000; Hawkins, 1990, 1994), approach dependency resolution in terms of the proximity of two units that are syntactically dependent on each other. Let us consider sentence (20a) and (20b). In Turkish, as the canonical word order is SOV, one can manipulate the distance between a subject (such as *öğretmen* ‘teacher’) and a verb (such as *kızdı* ‘got angry’) by changing the length of the intervening phrases. As can

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<sup>8</sup> An example of a syntactic dependency can be the one between the subject and the object of a sentence.

be seen from the examples, the intervening part is a single word (*öğrencilere*) in (20a) whereas it is relatively longer (five words; a relative clause and a postpositional phrase) in (20b). Here arises the question of whether the dependency between the subject and the verb (which are the same in both examples) resolves differently given that the time that has passed between processing the subject (i.e. *öğretmen* ‘teacher’) and the verb (i.e. *kızdı* ‘got angry’) differs between these two examples.

(20a) *Öğretmen öğrencilere kızdı.*

teacher students got\_angry

‘The teacher got angry with the students.’

(20b) *Öğretmen<sub>RC[geç kalan öğrencilere]</sub> PP[dersten sonra] kızdı.*

‘The teacher got angry with the students who were late after class.’

These accounts postulate that increasing the distance between two syntactically related items in a sentence should make it difficult for the parser to resolve the dependency between them. The reason for the processing difficulty due to an increase in distance between two dependent units is claimed to be the fact that the parsing mechanism is affected by the limited cognitive resources that it makes use of - such as working memory (Caplan & Waters, 2013, Gibson, 1998; Lewis & Vasishth, 2005). For instance, nested structures that contain RC embeddings are found to be hard to understand by native speakers of English (Gibson & Thomas, 1999). The sentence in (21a) consists of a single clause while the other two in (21b) and (21c) has one and two embedded clauses, respectively. It has been observed that while the sentence in (21b) is an acceptable structure, nesting yet another clause in the sentence as in (21c) renders it unacceptable (Gibson & Thomas, 1999). The reason for this is claimed to be the memory constraints (Gibson & Thomas, 1999), as a result, it gets more difficult as the distance between the subject and the verb of the

matrix clause increases because the language comprehension system needs to first resolve the dependency between the subjects, the objects, and the verbs of the embedded clauses. More specifically, before the parser decides that “the students visited the museum” it needs to understand that “the principal fired the teachers” and “the teachers dislike the students”.

(21a) The students visited the museum.

(21b) The students [who the teachers dislike] visited the museum.

(21c) The students [who the teachers [who the principal fired] dislike] visited the museum.

### 3.1.2 Anti-locality

Although the locality accounts can explain findings from several languages based on structural forgetting (i.a. Bartek, Lewis, Scheepers, & Tily, 2011; Hsiao & Gibson, 2003; Levy, Fedorenko, & Gibson 2013) there are other studies that suggest an increase in distance between two dependents can enable the parser to predict the dependent that is not yet encountered in the sentence more easily (Jaeger, Chen, Li, Lin, & Vasishth, 2015; Jaeger, Fedorenko, Hofmeister, & Gibson, 2008; Konieczny, 2000; Levy & Keller, 2013; Vasishth, 2003; Vasishth & Lewis, 2006). For example, surprisal theories (Futrell & Levy, 2017; Hale, 2001; Levy, 2008; Levy et al., 2009) postulate that processing difficulty is a product of how surprising a word is given the previous structure (Hale, 2001; Levy, 2008). It is argued that the parser is eager (Hale, 2001, p. 1) and the parser develops an expectation of an upcoming unit in the sentence based on what it has processed. In fact, it has been shown that increasing the distance between a subject and a verb can make speakers of SOV languages read the verb more quickly (Konieczny, 2000; Vasishth, 2003; Vasishth & Lewis, 2006).

For instance, in German, the distance between an auxiliary (such as “has”) and a verb head (such as “eaten”) can be manipulated, as shown in (22). The verb head *hingelegt* (‘put down’) is closer to the auxiliary *hat* (‘have’) in (22b) than in (22a) because the verb head can move in between a noun head and an RC that modifies the noun, as can be seen from the structure templates below the two sentences in (22).

(22a) *Er hat das Buch, das Lisa gestern*  
 He has the book that Lisa yesterday

*gekauft hatte, hingelegt.*

bought had put\_down

TP[NP T'[AUX VP[ NP[N RC] V]

(22b) *Er hat das Buch hingelegt, das Lisa*

He has the book put\_down that Lisa

*gestern gekauft hatte.*

yesterday bought had

TP[NP T'[AUX VP[ NP[N] V RC]

‘He put down the book that Lisa bought yesterday.’

(Konieczny, p. 631, 2000)

Thanks to these two potential constellations in German, Konieczny (2000) manipulated the distance between the auxiliary and the verb head to test whether the change in distance between the two dependent units (i.e. the auxiliary and the verb head). When the verb is farther away from the auxiliary, it was read faster than the verb that was immediately adjacent to the auxiliary (Konieczny, 2000). This is taken to be a piece of evidence that is against the claim of the locality accounts that the shorter the distance between two dependents is, the easier processing becomes. In other words, Konieczny (2000) considers the relative decrease in reading times in

structures like (22a) compared to reading times in (22b) as an indicator of the fact that processing is easier in (22a) than in (22b) although the distance between *hat* and *hingelegt* is longer in (22a) than in (22b). This finding is not expected by the locality accounts because they predict the otherwise.

### 3.1.3 Content-addressable retrieval model

There is yet another model, namely the content-addressable retrieval model (McElree, 1996, 2006), which postulates that the parser relies on the linguistic features of the phrases in a sentence to resolve syntactic dependencies. As a result, in the content-addressable retrieval model, the complexity of resolving a dependency is attributed to interference that occurs when two or more units share the same features rather than an idea of processing difficulty modulated by the proximity of syntactic units. The concept of processing difficulty in the content-addressable is referred to as similarity-based retrieval interference (Jäger, Engelmann, & Vasishth, 2017). Let us consider the sentence in (23) to understand how similarity-based retrieval interference occurs. Sentence (23a) and sentence (23b) are of approximately the same length. However, in (23b) there is an extra noun phrase (“brother”) in the place of the adverb (“always”) in (23a). Under the content-addressable retrieval model, it is assumed that the amount of interference caused by the fact that there are similar units in the sentence is bigger in (23b) than in (23a). More specifically, when the parser processes the verb “loved”, it needs to retrieve the subject of this verb to integrate it into the structure. The parser does so by using the linguistic features (such as syntactic category, animacy, number, case-marking) that are cued for during encoding. In other words, a linguistic unit to-be-retrieved for another one is sought for by means of syntactic and semantic features as they are represented in memory

(Jäger, Engelmann, & Vasishth, 2017). For instance, the verb “loved” needs an NP that is [+animate]. In (23a), there is only one candidate that meets these requirements in the same clause, which is “John”. In (23b), however, there are two candidates that meet these requirements in the same clause with the verb “loved”, which are “John” and “John brother”. Since these two NPs are similar with respect to their features, the retrieval of the subject of the verb “loved” is subject to interference, which generates the possibility of “John” being considered the subject whereas “John’s brother” is the correct candidate (Jäger, Engelmann, & Vasishth, 2017).

(23a) Mary knew that John always loved her.

(23b) Mary knew that John’s brother loved her.

If “John” can be taken to be the subject of the verb “loved” in (23b) due to similarity-based interference, people may sometimes answer a question about the subject of that verb incorrectly. Besides, the verb “loved” might be read slower in (23b) than in (23a) given that there are two candidates for the subject in (23b) while there is only one candidate in (23a). Interference effects that occur during cue-based retrieval have been investigated with respect to various linguistic phenomena including subject-verb dependencies (Dillon, Mishler, Sloggett, & Phillips, 2013; Lewis & Vasishth, 2005; Vasishth & Lewis, 2006; Wagers, Lau, & Phillips, 2009), NPI processing (Parker & Phillips, 2016; Vasishth, Bruessow, Lewis, & Drenhaus, 2008), and reflexive processing (Dillon et al., 2013; Jäger, Engelmann, & Vasishth, 2017; Parker & Phillips, 2016), and missing-VP effects (Haussler & Bader, 2015).

#### 3.1.4 The good-enough processing approach

Although there are numerous models that attempt to explain how the operations relating to dependency resolution take place during online processing, it is definite

that those operations take place at a very high speed. But how does the human language processing system handle processing and comprehension given that it is ‘incremental and rapid’ (Marslen-Wilson, 1973; 1975)? Psycholinguistic accounts split up into two in the tracing of the source of this high-speed cognitive mechanism. The first group of psycholinguistic models assumes that the language comprehension system eventually considers all available information in determining its interpretation as to what is being processed, resulting in single, definite interpretations (Frazier & Fodor 1978; Frazier 1978; Frazier & Rayner 1982; MacDonald, Pearlmutter, & Seidenberg, 1994; Spivey & Tanenhaus 1998; Stevenson 1994; Trueswell, Tanenhaus, & Kello, 1993). The second group of models claims that the language comprehension system does not make use of all available information since it is impractical (Ferreira, 2003; Sanford, 2002; Sanford & Sturt, 2002). Rather, what it does is that the system develops certain strategies, which are referred to as heuristics, which have been studied in the studies on sentence processing (i.a. Amy & Vion, 2007; Bever, 1970; Demiral, Schlesewsky, & Bornkessel-Schlesewsky, 2008; Ferreira, 2003, Papadopoulou & Clahsen, 2003; Swets, Desmet, Clifton, & Ferreira, 2008), in order to accelerate the process by skipping some sub-operations or ignoring some part of the available information. The present study maintains a position on the latter side, namely, the Good-Enough processing approach (Ferreira, 2003; Ferreira, Bailey & Ferraro, 2002; Ferreira & Patson, 2007; Sanford & Sturt, 2002; Swets et al., 2008; Townsend & Bever, 2001). In this approach, it is claimed that the human parser does not always build up complete structures, rather it processes linguistic input in way that it obtains ‘shallow’ interpretations. The good-enough approach diverges from deterministic models in some respects. While deterministic models can generate incremental parses, they give way to local ambiguities where the

comprehender has to decide among at least two possibilities, although the necessity of deciding between possibilities does not seem to be the case (as discussed by Abney, 1989). For example, the verb ‘hear’ can be followed by phrases with different syntactic categories including noun phrase, adverb phrase, prepositional phrase, and complementizer phrase, as shown in (24).

(24a) Mary heard something. (hear + NP)

(24b) Mary hears well. (hear + AdvP)

(24c) Mary has not heard from John for a long time. (hear + PP)

(24d) Mary did not hear that the old man had died. (hear + CP)

As can be seen above, the verb hear can have four syntactically different continuations. A deterministic parser would need to choose one of these continuations as soon as the verb hear is processed even though there is no supporting linguistic evidence. If the structure unfolds in a way that conflicts the decision of the parser, however, the parser should go back and review the structure. For example, if the comprehender reads the verb “hear” and determines that the upcoming phrase will be an NP, but the next phrase turns out to be a CP, the parser should go back and revise its initial interpretation, which may also result in some processing cost. Nevertheless, it looks as though language users do not “backtrack” in none of the structures in (24), as discussed by Abney (1989, p. 130-131).

As sentence processing is an operation that is performed very rapidly (Marslen-Wilson, 1973; 1975) and the parser faces ambiguities very often in comprehension, it is put forth in the Good-Enough processing approach (Ferreira, 2003; Ferreira et al., 2002; Ferreira & Patson, 2007; Sanford & Sturt, 2002; Swets et al., 2008; Townsend & Bever, 2001) that the human language comprehension system should process language not only based on syntactic algorithms but also other types

of available information (for example, plausibility of a specific reading over another one). Processing sentences with the help of other available information can give way to the development of parsing strategies, which are referred to as heuristics.

Under the good-enough approach, it is assumed that the parser builds up good-enough representations, that is, the parser sometimes relies on incomplete representations that are adequate in most cases to arrive at an interpretation. In this respect, the type of parser assumed in the good-enough approach is different from other parsers that build up detailed, complete representations. Therefore, the parser assumed in the good-enough approach is not always accurate given the input it processes since it computes local interpretations rather than computing a global one that is solely informed by syntactic information and valid. Those local interpretations can sometimes interfere with the meaning of the entire structure, which gives way to break-downs and inaccuracies in sentence comprehension. In what follows, I talk about some evidence from studies suggesting that sentence comprehension is affected by underspecified representations, that comprehenders are fallible during online sentence comprehension, and misinterpretations during comprehension are due to incomplete reanalysis.

### 3.2 Underspecification in ambiguity processing

Psycholinguistic phenomena pertaining to ambiguity resolution provide a fruitful area of research. There has been an immense amount of research on how the human language comprehension system deals with ambiguous structures including relative clause attachment (i.a. Hemforth, Fernandez, Clifton, Frazier, Konieczny, & Walter, 2015; Hemforth, Konieczny, Seelig, & Walter, 2000; Kamide & Mitchell, 1997; Papadopoulou, 2003; Sekerina, 2004; Traxler, 2007), reflexive processing (i.a.

Dillon, 2014; Dillon, Chow, Wagers, Guo, Liu, & Phillips, 2014; Jaeger, Engelmann, & Vasishth, 2015; Kush & Phillips, 2014; Sturt, 2003; Xiang, Dillon, & Phillips, 2009) and what the comprehender understands from those structures.

Under the Construal Hypothesis (Frazier & Clifton, 1996), it is assumed that only ‘primary’ relations that are needed for grammaticality (such as establishing the relationship between a subject and an object) are structurally determined. However, secondary relations that pertain to adjuncts and their attachment sites are established on the basis of context. More specifically, adjuncts such as relative clauses are assumed to be more likely to attach to one of the potential attachment sites that is more salient in the context. The reason why relative clauses are attached to an attachment site on the basis of contextual cues as opposed to structural ones is argued to be the fact that relative clauses are not obligatory for the structure but necessary for the context. Frazier and Clifton (1996) arrives at this conclusion based on their findings from experiments where they used extraposed RCs as in “John knew the daughter of our teacher, who died recently.”. In the Construal Hypothesis (Frazier & Clifton, 1996), it is assumed that the thematic domain for extraposed RCs like “who died recently” is the whole sentence. Therefore, it should attach to the attachment site that is relevant to the overall meaning of the sentence.

There are quite a few syntactic and semantic phenomena that have been discussed with regard to the superficiality of processing. Distributivity is one notion that has been shown to be influenced by the fact that sentence comprehension may be superficial. Frazier, Patch, and Rayner (1999) showed that when people are presented with a globally ambiguous sentence like ‘Katy and Justin saved \$150’, they do not seem to prefer one of the two possible readings, namely the distributed

reading and the non-distributed reading<sup>9</sup>. This means that comprehenders obtain a general understanding of globally ambiguous sentences rather than committing to a specific reading chosen from the possible ones.

In their study on relative-clause attachment in English, Swets et al. (2008) have shown that the way that people treat ambiguity can change in accordance with task demands. More specifically, people seem not to engage in disambiguation unless they are required to. For instance, when the task permitted participants to process sentences shallowly, they read those sentences faster. However, when task required a definite interpretation or when participants were asked a question that necessitated a decision as to the attachment site for the RC, reading times and response times got increased (Swets et al., 2008).

To sum up, people do not necessarily disambiguate an ambiguous structure unless there is a motivation to do so (for example, the comprehender is asked or the situation requires them to choose a specific reading). It is argued that the reason why the comprehender does not happen to always disambiguate is that the complete specification of every bit of a given sentence is not really needed or wanted (Sanford & Sturt, 2002).

### 3.3 Illusions of grammaticality

Another set of phenomena that suggest the language comprehension system is not always accurate is illusions of grammaticality. An illusion of grammaticality can be defined as the comprehender's failure to detect the ill-formedness of a structure, resulting in an incorrect judgment (i.e. perceiving an ungrammatical structure as grammatical). Illusions of grammaticality have been observed in various structures

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<sup>9</sup> The distributed reading implies that Katy and Justin each saved \$150 whereas the non-distributed reading implies that Katy and Just together saved \$150 in total.

and in different languages. These illusions manifest themselves in different measures including reading times (Kazanina, Lau, Yoshida, Lieberman, & Phillips, 2007), eye movements (Dillon, Mishler, Sloggett, & Phillips, 2009; Runner, Sussman, & Tanenhaus, 2006; Vasishth, Brüssow, Drenhaus, & Lewis, 2008), event-related potentials (Xiang, Dillon, & Phillips, 2009), online perceived grammaticality judgments (Clifton, Frazier, & Deevy, 1999; Haussler & Bader, 2015), and offline perceived grammaticality judgments (Gibson & Thomas, 1999). Some illusions stem from semantic anomalies while some others stem from structural violations.

One of the initial observations that comprehenders are fallible during sentence comprehension is the so-called Moses illusions (Erickson & Mattson, 1981; Kamas, Reder, & Ayers, 1996). The studies examining this illusion showed that when participants are asked “How many animals of each kind did Moses take on the ark?” they often seem not to understand the problem with the question, which is the fact that it is Noah who is believed to take animals on the ark, not Moses. Yet, most people say “two” as an answer to that question. Barton and Sanford (1993) has shown that people tend to fall into a similar ‘illusion’ with semantically anomalous structures. For instance, when participants were asked a question about where to bury the \*survivors\* of an accident, half of them responded like “they should be buried where their relatives want them to be”. This question does not make any sense because the question is unreasonable to ask in the first place since survivors are not typically buried. Another piece of evidence suggesting that people get faulty readings from sentences comes from depth-charge sentences (Wason & Reich, 1979; Natsopoulos, 1985). An example of ‘depth-charge’ sentences is “No head injury is too trivial to be ignored”, which can paraphrase into “No matter how trivial a head injury seems, it should be ignored”. However, people get the interpretation that head

injuries should not be ignored regardless of their severity. Therefore, it looks as though people either do not process the sentence at length or somehow change their initial interpretation that does not fit the logical world. These findings point out that people's pragmatic knowledge prevents them from noticing the unusual content of the above-mentioned sentences with semantic anomalies, or else, that people engage in some sort of a pragmatic normalization process (Fillenbaum, 1974). It has also been shown that language users sometimes do not notice the ungrammaticality in sentences like 'A professor that no student likes will ever say that'. This phenomenon where an unlicensed negative polarity item, such as 'ever', is erroneously licensed by a licenser, such as 'no', and the comprehender does not detect the ungrammaticality suggests evidence for the so-called illusory NPI licensing (Parker & Phillips, 2016; Xiang, Dillon, & Phillips, 2009). The last batch of phenomena I will mention in the context of grammaticality illusions is the missing-verb effect. This effect occurs when language users do not realize that a sentence is missing one of the grammatically required verbs or when language users find a missing verb sentence equally or more acceptable / easier to understand than a grammatical version of the sentence. This effect has been observed in English (Gibson & Thomas, 1999), in French (Gimenes, Rigalleau, & Gaonac'h, 2009), and possibly in Turkish (Dokudan & Logačev, 2018). All these pieces of evidence that show that the human language comprehension system is fallible, which can also suggest that sentence comprehension is at least some of the time superficial.

### 3.4 Misunderstanding and incomplete reanalysis in sentence comprehension

Christianson et al. (2001) asked the question of whether people understand what they should understand from garden-path sentences. That is if they successfully reanalyze

the structure and get the correct interpretation. In their self-paced reading experiments, Christianson et al. asked participants comprehension questions as well as confidence ratings after garden-path and non-garden-path sentences. Those confidence ratings (YES/NO questions) asked how confidently participants said that they understood the sentence. Their first experiment had 6 conditions which are exemplified in (25). What the researchers manipulated is as follows: the presence of a local ambiguity (garden-path or not), the plausibility of the misinterpretation (plausible or implausible), and the duration of the ambiguity (the ambiguous phrase is short or long).

(25a) Garden-path, plausible misinterpretation

While Bill hunted the deer (that was brown and graceful) ran into the woods.

(25b) Garden-path, implausible misinterpretation

While Bill hunted the deer (that was brown and graceful) paced in the zoo.

(25c) Non-garden-path

While Bill hunted the pheasant the deer (that was brown and graceful) ran into the woods.

(Christianson et al., 2001, 373)

As can be seen from the above summary of the conditions, the difference between (25c) and the other two is that (25a) and (25b) are garden-path sentences whereas (25c) is not. Since (25c) is not a garden-path sentence it served as a control condition which enabled the researchers to measure the garden-path effect. The plausibility of the misinterpretation concerns the fact that Bill hunting the deer is more plausible in the woods than in the zoo. This plausibility factor originates from

the comprehender's world knowledge and provides an opportunity to see if reanalysis is more likely to be completed when the comprehender's pragmatic knowledge is violated as in (25b) than in (25a). The length of the locally ambiguous phrase is manipulated by modifying the NP (i.e. the deer) with an RC (i.e. that was brown and graceful) to see how the duration of the ambiguity matters as it has been suggested in previous research (Tabor & Hutchins, 2004).

Having read each sentence, participants were required to answer a comprehension question about the sentence. The questions were in the form of the following: "Did Bill hunt the deer?" When participants said YES it was taken as an incorrect response indicating that they could not completely reanalyze the structure, causing the misinterpretation to be maintained. The response NO, on the other hand, was the correct answer to the question indicating that the participant got the correct interpretation. The analyses of the responses to the comprehension questions showed that the error rate was fairly high for the garden-path sentences where the ambiguous region was long and the misinterpretation was plausible: Participants answer the comprehension questions incorrectly in more than 40% of the cases, showing that they were substantially inaccurate in answering the questions. The error rate was approximately 30% for the garden-path sentences where the ambiguous region was short, and the misinterpretation was plausible. For the garden-path sentences where the misinterpretation is implausible, the error rates were over 30% and around %10 when the ambiguous region was long and short, respectively. Given that participants reported that they were highly confident (the average confidence rating was 3.2 over 4) in answering the comprehension questions finding these error rates was considered interesting.

In their second experiment, Christianson et al. (2001) reversed the position of the subordinate clause such that the local ambiguity resulting from the verb (e.g. “hunt”) in the subordinate clause being optionally transitive would disappear as shown in (26).

(26) The deer that was brown and graceful ran into the woods while Bill hunted.

(Christianson et al., 2010)

The reason why the researchers had the non-garden-path versions of their structures by putting the subordinate clause after the main clause is that it would show them if people still take “the deer” as the object of “hunting” even though the NP is not immediately after the verb. The researchers justify the use of this control condition with the fact that there needs to be a baseline indicating if participants consider someone who is hunting to hunt the deer even if it is not stated in the sentence as such. This baseline structure should provide an understanding of how often participants regard “the deer” as the syntactic object of the verb “hunted”. The second experiment run by Christianson et al. was different from their first experiment also in that they asked two comprehension questions. One question asked whether “Bill hunted the deer”, and the other asked whether the deer ran into the woods. If participants answer the latter question correctly, it would show that reanalysis took place (at least partially) because participants need to reanalyze the structure to see “the deer” as a subject. Lastly, they made modifications in the manipulation regarding the length of the ambiguous region. The head noun of the NP “the deer” was either modified by an adjective phrase (e.g. “brown and graceful”) or by a relative clause (e.g. “that was brown and graceful”) to alternate the position of the head noun. The researchers hypothesized that reanalysis should be easier in the

sentences with an adjectival modification (i.e. pronominal), compared the sentences with an RC modification (i.e. postnominal). The experimental structures of the second experiment are shown in (27).

(27) Summary of the structures of the second experiment of the Christianson and his colleagues' (2001) study:

a. Garden-path structures

While Bill hunted the brown and graceful deer ran into the woods.

While Bill hunted the deer that was brown and graceful ran into the woods.

b. Unambiguous structures

The brown and graceful deer ran into the woods while Bill hunted.

The deer that was brown and graceful ran into the woods while Bill hunted.

The results of Christianson et al.'s second experiment suggest that participants were very accurate in answering the comprehension question about the main clause (e.g. 'Did the deer run into the woods?') as the percentage of the incorrect responses were fairly low. However, the other question type which asked if Bill hunted the deer was answered incorrectly more than half of the time in both the garden-path and non-garden-path conditions. This finding points out that participants tended to take the deer as the object of the verb hunted no matter whether they got garden-pathed or not. This misinterpretation effect was found to be more pronounced when the head noun (i.e. 'deer') is farther from the disambiguating verb (i.e. 'ran'), in other words, in the garden-path sentences where the head noun was modified by an RC and closer to the verb 'hunted'. As for the level of participants' confidence in answering the comprehension questions, the confidence ratings for incorrect

responses were as high as for correct responses. Given these results, the researchers conclude that the reanalysis operation was partially hindered: participants get one of the two interpretations (one coming from the subordinate clause, the other coming from the main clause) correctly, but the other interpretation is ‘infected’ by the local ambiguity, making it into a misinterpretation.

Christianson et al. (2001) ran one last experiment where they introduced a manipulation concerning the type of the verb. They used both optionally transitive verbs such as “hunt” as they did in their first two experiments and verbs like “dress” which can either be a regular transitive verb or a verb that takes its subject as its object (as in ‘Anna dressed up’). A garden-path sentence from the third experiment of Christianson et al. (2001) is shown in (28).

(28) While Anna dressed the baby spit up on the bed.

This sentence is different from “While Bill hunted the deer ran into the woods” because “the deer” still can be the object of the verb “hunted” even after a successful reanalysis whereas in (28), ‘the baby’ can be taken as the object in the first parse, however, “Anna” must be the one that gets dressed. The researchers disambiguated their sentences by putting a comma in between the two clauses in addition to reversing the clause order as in the second experiment: “While Anna dressed, the baby spat up on the bed”. Both the sentences with the reversed order and the sentences with a comma served as non-garden-path control items. The results of the third experiment indicate that the processing of the sentences with an optionally transitive verb was found to be similar to that of the same structures in the previous experiments. In other words, participants in this experiment also thought that “[the man who hunted] hunted the deer”, so to say. However, this finding was more robust for the garden-path sentences with an optionally transitive verb. When the verb in the

non-garden-path sentences was a reflexive absolute transitive verb (e.g. “dressed”), participants did not think that Anna dressed the baby but that she dressed herself. Nevertheless, the rate of accuracy in answering the comprehension question was found to be the same for the garden-path sentences with an optionally transitive and reflexive absolute transitive verbs. The findings of the third experiment are further evidence suggesting that people cannot cancel their first interpretation gotten from a first parse that turns out to be incorrect due to the structure being a garden-path.

The main three inferences made by the researchers out of the above findings are as follows: 1. The misinterpretation from an incongruent parse is somehow maintained (i.e. it “lingers”). 2. This lingering effect gets more pronounced as the misparse continues longer (i.e. the ambiguous region of the sentence is longer), which is similar to the “digging-in” effects (Tabor & Hutchins, 2004) which posit that reanalysis gets more difficult as the parser’s commitment to an incorrect parse is greater. 3. The lingering effect can be canceled by means of plausibility. To account for these findings, the researchers propose three alternative explanations of the misinterpretation of garden-path sentences. All these three explanations (which are non-syntactic as they are called by the authors) of the findings fail at certain points (see Christianson et al., 2001, p. 11-13 for a thorough discussion of these explanations). Therefore, the researchers conclude that misinterpretations they observed stem from the breakdown in processing the structure, followed by the inability to obtain a complete analysis of the entire structure during reanalysis. More specifically, Christianson et al. (2001) argue that the NP that is seen as the object of the subordinate clause (e.g. “the deer”) is stolen from that clause to be the subject of the main clause, which is obligatory. In a nutshell, this study suggests that semantic roles (e.g. agent, patient) are assigned as the parser forms local interpretations (which

give way to the garden-path effect) and that the comprehender's final interpretation of garden-path sentences is affected by the initial interpretation of a part of the sentence (i.e. lingering effects).

Ferreira & Henderson (1991a) used structures that are similar to the ones Christianson et al. (2001) used (garden-path and non-garden-path) as well as some unrelated grammatical and ungrammatical sentences. They employed a rapid serial visual presentation, which is very similar to speeded acceptability judgment task with the only difference that the entire sentence is displayed on the screen for 250 ms in RSVP. The average ratings for the garden-path sentences and non-garden-path differed from each other (82% and 69%, respectively).

## CHAPTER 4

### THE USE OF HEURISTICS IN SENTENCE COMPREHENSION

#### 4.1 The use of heuristics in cognitive tasks

It was argued that the language comprehension system should operate on some syntactic algorithms plus certain heuristics that would make the process more rapid and more economical (Townsend & Bever, 2001). The research that has suggested sentence processing is not executed deeply (Carreiras, Garnham, Oakhill, Cain, 1996; Ferreira et al., 2002; Oakhill, Garnham, & Vonk, 1989; Sanford & Sturt, 2002) also refers to the use of strategies in sentence comprehension. There is also evidence coming from ERP (Demiral, Schlesewsky, and Bornkessel-Schlesewsky, 2007) indicating that speakers of Turkish, a subject-first language, tend to regard the first noun phrase of a sentence as the subject.

Before talking about the evidence supporting and against the use of heuristics in sentence comprehension, I should provide a definition of 'heuristic'. A heuristic, in general terms, is a strategy that is a product of the human mind, which is come up with by means of previous experiences to help various cognitive systems solve a problem (Myers, 2010). Suppose that your mathematical skills are being tested in a multiple-choice exam and you are trying to solve the equation given in (29).

$$(29) x^2+x-56=0$$

There can be several ways that lead to the solution of this problem. One way to solve it is to factor the equation. However, if you do not even know how to factor the equation, you could simply try out the options that are presented with the question one by one as the exam is a multiple-choice one until you find the

correct answer, that is the value of  $x$  in the option yields the result (e.g. 0) when the value is put in the equation. This can be a strategy that one might use without even knowing the conventional methods (assuming the knowledge of basic algebra and four operations). Hence, it can be said that heuristics can be useful in situations where only partial knowledge is available. Moreover, partial knowledge does not even have to be part of the knowledge that is originally needed to solve the problem.

Heuristics are not only used in mathematical problems, of course. There are many areas where certain strategies are possibly used. These areas may include diverse cognitive tasks (for example, vision, navigation, decision-making, etc.). In psychology, heuristics generally come into question in the discussion of judgment and decision-making. The concept as is used in psychology was mentioned by Simon (1956), who also put forth the term ‘satisficing’ that posits people opt for problem-solving strategies that are ‘good-enough’ to deal with the situation at issue (as explained by Gigerenzer & Todd, 1999). The idea of using heuristics in decision-making was developed into a theory by Kahneman, Tversky, and Slovic (1982), who discussed heuristics in the context of judgment and uncertainty. Heuristics are also explored in terms of cognitive biases which can mislead the decision maker such as the availability heuristic, the mere exposure effect, the serial position effect. Since the present study is mainly concerned with the use of heuristics in sentence comprehension, I will now turn to the psycholinguistic literature on heuristics.

#### 4.2 The use of heuristics in sentence processing

The term heuristic is used in psycholinguistics to refer to parsing strategies that can make the language comprehension system skip some sub-operations or ignore some part of the available information (i.a. Amy & Vion, 2007; Bever, 1970; Demiral,

Schlesewsky, & Bornkessel-Schlesewsky, 2008; Ferreira, 2003, Papadopoulou & Clahsen, 2003; Swets, Desmet, Clifton, & Ferreira, 2008). In other words, it is assumed that the language comprehension system can use heuristics that are simple and adequate for executing most linguistic operations (Ferreira et al. 2002, Ferreira & Patson, 2007; Frank et al. 2012). Although only a parse that is made based solely on syntactic information (ignoring meta- and non-linguistic information) is guaranteed to result in an accurate representation and interpretation of the input, a parse to which heuristics have contributed to can take less time to attain (Simons & Levin, 1997). Therefore, a parser that make use of heuristics may fail to get the correct interpretation of sentences (as discussed in Chapter 3, in the context of misunderstanding and grammaticality illusions in sentence processing).

One of the first heuristics assumed to be used in sentence comprehension was put forth by Bever (1970), which is the canonical sentoid strategy. This strategy, as briefly discussed in Chapter 1, posits that when native speakers of English read or hear a sentence they decide the grammatical roles of the components of the sentence by mapping the syntactic categories of those components (e.g. noun, verb) onto the word order of English (subject-verb-object). More specifically, in English, a noun phrase that precedes a verb tends to be considered the subject and a noun phrase that follows a verb tends to be considered the object of the sentence. As a result, a noun phrase that comes after a verb should be taken as being in the same clause with the noun phrase that comes before the same verb. Bever (1970) explains the reason for the garden-path effect occurring in sentences like “The horse raced past the barn fell.” by means of the canonical sentoid strategy.

The first question that should be asked is why the language comprehension system should use heuristics? Although the language comprehension

system is expected to use certain strategies given that other cognitive systems do use strategies that ease and speed up the operation, it is essential to understand why and how the language comprehension system relies on heuristics. The argument behind the need for the use of heuristics is that the language comprehension system needs to make use of simple heuristics that would speed up the mental operations involved in comprehension (Gigerenzer & Todd, 1999). Gigerenzer and Todd based this argument on the assumption that taking every possibly useful piece of information into consideration is heavy for a system that is restricted in terms of the resources it can use and time. For this reason, they claim that it is biologically not feasible (Gigerenzer & Todd, 1999). Although discussions regarding the use of heuristics in sentence comprehension are mostly associated with the Good-Enough approach, the idea that the language comprehension system utilizes some strategies traces back to former models. For example, the Garden-Path model of sentence comprehension subsumes the principle of simplicity (Frazier, 1987) which posits that the parser should make attachments as simple as possible. As a result, the principle of simplicity is a heuristic by which the parser goes for a potentially faster parse. Two other strongly related principles assumed in the Garden-Path Model, namely late closure and minimal attachment (Frazier & Fodor, 1978), have more specific implications. Let us consider the example in (30), where the adjunct ‘yesterday’ as claimed to be preferred as being attached to the subordinate clause rather than the main clause (Frazier, 1978; Frazier & Fodor, 1978).<sup>10</sup>

(30) Tom realized that the girl crashed her car yesterday.

The sentence in (30) is globally ambiguous such that the noun phrase ‘yesterday’ can attach either to the main clause or to the subordinate clause. However,

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<sup>10</sup> There are exceptions to this preference when the context tells the parser to choose the other interpretation.

according to the late closure principle, the parser prefers to attach it to the subordinate clause. In the cases where an ambiguous structure with interpretations that happen to have the same number of nodes, this principle applies such that the most recent attachment site is chosen for the phrase creating the ambiguity. The other principle that is called the minimal attachment principle proposed by Frazier (1978) posits that the parser should make structural decisions compatible with the input that has been processed thus far in the sentence, which may generate garden-path effects. For example, in the sentence given in (31), the first parse would tell the comprehender that the direct object of the verb ‘told’ is ‘the story’. However, the parsing process breaks down as ‘the story’ turns out not to be the actual direct object. Instead, the CP ‘that it was written by himself’ has to be the direct object. This garden-path effect emerges due to the strategy that subsumes the minimal attachment principle.

(31) The man told the girl the story had amused that it was written by Hemingway.

Several experimental studies have provided evidence for the use of the late closure principle in sentence comprehension (i.a. Ferreira & Clifton, 1986; Frazier & Rayner, 1982; Rayner et al., 1983). The evidence that suggests people may misinterpret sentences (i.a. Christianson et al., 2001) has also challenged the idea that the comprehender arrives at an accurate semantic interpretation that is derived from the syntactic representation of the sentence (as discussed by Bader & Meng, 2018). Therefore, unlike some approaches assuming an algorithmic parser that obtains interpretations based on syntactic representations (i.a. MacDonald & Seidenberg, 2006; Mitchell, 1994; Pickering & van Gompel, 2006), it is proposed that parsing tendencies or strategies might contribute to the comprehender’s overall interpretation

of a sentence, as discussed by researchers that have worked on garden-path structures and misinterpretation during online sentence comprehension (Christianson et al., 2001; Christianson, et al., 2010; Ferreira & Clifton, 1986; Ferreira, 2003; Rayner, 1982; Rayner et al., 1983).

One of the parsing strategies proposed in the previous literature is, as I have mentioned before, the canonical sentoid strategy (also known as the NVN strategy), whereby the comprehender tends to expect that the agent in a sentence precedes the patient (Bever, 1970; Fodor et al., 1974). Ferreira (2003) tested this hypothesis with unambiguous non-canonical structures in English, including passive constructions, and object clefts<sup>11</sup>, as well as structures where the canonical word order of the language (SVO) is maintained, including active constructions subject clefts<sup>12</sup>. Ferreira (2003) compared these structures with respect to how they are understood in a naming task where participants were required to name the agent (i.e. who does the action) and the patient (i.e. who is being affected by the action) in addition to other concepts like location (i.e. where the event takes place), time (i.e. when the event takes places), the color of a referent in the sentence. The accuracy in naming what was being asked about the sentence was analyzed. The results of this experiment have indicated that people are less accurate in deciding the thematic roles in passive constructions than in active constructions and that people are less accurate in deciding the thematic roles in object clefts than in subject clefts. These findings point out that the canonical word order of the language contributes to the comprehender's interpretation of the agent and the patient in a sentence. Christianson, Luke, & Ferreira (2010) obtained results that provide evidence for

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<sup>11</sup> Example: It was the man who the dog bit.

<sup>12</sup> Example: It was the dog who bit the man.

misinterpretation, nevertheless, the effect was found only for implausible sentences and for questions that asked about the agent. Taken together, these findings suggest that people may arrive at a shallow and sometimes incorrect interpretation of a structure rather than a detailed one based on the syntactic representation of the structure. However, the good-enough approach does not posit that syntactic algorithms are not used while understanding sentences. Instead, it is argued that there are two independent processes that take place simultaneously: a process whereby a syntactic representation is computed through linguistic properties of the input being processed and another process whereby a smaller set of information (such as word order and plausibility) is taken into consideration to arrive at an interpretation through heuristic rules. When the process that involves the application of heuristic rules generates the interpretation, the outcome can be faulty, resulting in misinterpretations and illusions. Although the end result can be undesirable when heuristic rules apply, this process is more economical in terms of the use of time (Karimi & Ferreira, 2016).

Plausibility is another heuristic principle that can make the comprehender evaluate and alter the interpretation that is generated by means of syntactic properties (van Herten, Chwilla, & Kolk, 2006). When people read sentences where the attachment of a relative clause is implausible as in “The ladder that climbed the painter suddenly fell”, van Herten et al. (2006) did not find a N400 effect, instead, they found a P600 effect, suggesting that participants did not detect the semantic anomaly of the sentence. The authors argue that the comprehender reviews the implausible interpretation gotten from the syntactic representation such that it makes sense.

Since languages exhibit variation with respect to their syntactic properties (such as word order, the use of case marking), various parsing strategies may be in effect in different languages. However, I will focus solely on animacy as an information source that can affect how the parser processes a structure, consequently, what the parser understands from the structure.

#### 4.3 Animacy as used in developing parsing strategies

When we look at individual sentences in any given language, we often encounter cases where the sentence communicates a message concerning an event that takes place between two participants (Hopper & Thompson, 1980). For example, in sentence (32a), “the artist” is interpreted as the admirer and “the sculpture” is interpreted as the admiree (Lamers, 2007). Although semantic roles (e.g. agent, patient) go hand in hand with syntactic functions (e.g. subject, object) in the argument structure of verbs (Jackendoff, 2003), not all subjects have the same semantic role as “the artist” or not all objects have the same semantic role as “the artist”. If we change the verb “admired” with something like “please” as in sentence (32b) (Lamers, 2007, p. 126), we will recognize the significance of animacy.

(32a) The artist admired the sculpture.

(32b) # The artist pleased the sculpture.

The difference between the two sentences (32a and 32b) in terms of grammaticality originates from the fact that the verb “admire” and “please” assign different semantic roles although they both require two arguments (i.e. a subject and an object). More specifically, the verb “admire” can take an object regardless of the animacy of the NP that is to be the object while the verb “please” requires the object to be an NP that is [+ human] or [+animate], which is why (32b) is an unacceptable sentence.

Lamers (2007) argues that if animacy makes a difference in the interpretation of the structure even in English whose word order is strictly SVO, animacy should play an important role in languages with relatively free word orders.

As we have just seen, some verbs like “please” restrict the semantic set of their potential objects based on animacy whereas other verbs like “admire” do not necessarily select an animate or inanimate object. The same contrast can be found with subject selection, as well. In addition, the same verb may assign different theta-roles to its subject based on the animacy of the subject NP. For example, verbs like “roll” are not semantically specified with respect to the volition of their potential subject (Primus, 2012) as opposed to verbs like “laugh”, as shown in (33).

(33) Subjects that are underspecified or specified with regard to animacy

- a. Klemens rolled down the street. (volitional)
- b. The ball rolled down the street. (non-volitional)
- c. Matthias laughed.
- d. \*The car laughed.

These data above show us that whether or not the act is volitional depends on the animacy of the subject for the verb “roll” because both an animate subject (a) and an inanimate subject (b) can be used with the verb without any grammatical conflict. Yet, the animate subject (i.e. “Klemens”) doing rolling is interpreted as a volitional act whereas the inanimate subject (i.e. “the ball”) doing rolling is not interpreted as a volitional act. For the verb “laugh”, on the other hand, an animate subject (i.e. “Matthias”) does not create any grammatical conflict (c) while an inanimate subject (i.e. “the car”) renders the sentence ungrammatical (d) because a car cannot laugh which says that the possible set of subject for this verb is

predetermined since only animate nouns are potential subjects for it. That is to say, whether the subject has volition is not semantically underspecified for the verb “laugh” unlike the case with the verb “roll”. As the semantic interpretation of a proposition is influenced by its subject doing the verb volitionally which is determined by animacy (as discussed by Primus, 2012), animacy can and should be a cue used by the language comprehension system in deciding the semantic relations in a sentence.

Animacy can also be crucial in some structures where the thematic roles are assigned in a non-standard way and case marking provides ambiguous information, as in the case of Dutch (Lamers, 2012; Lamers & Hoop, 2004). In Dutch, determiners are marked for case and gender. However, sometimes determiners in Dutch can be ambiguous such that the same noun phrase can be - potentially - the subject or the object of the sentence because it is not certain that the determiner of that noun phrase is marked with nominative or accusative. When case marking does not indicate what the subject is and what the object is, a sentence like (34a) is globally ambiguous. Nevertheless, Lamers (2012) states that as the preference for the subject-object reading is stronger than that for the object-subject reading, the first noun phrase (i.e. *de foto*) is more likely to be taken as the subject than the second noun phrase (i.e. *de atleet*). However, in sentence (34b) and sentence (34c), the ambiguity is resolved by means of animacy. Both sentence (34b) and sentence (34c) contain an animate noun phrase (i.e. *de atleet* ‘the athlete’) and an inanimate noun phrase (i.e. *de foto* ‘the picture’) but in (34b), the first noun phrase is animate and the second one is inanimate, and in (34c), it is vice versa. Interestingly, both sentences carry the same meaning although the order of the animate and the inanimate noun phrases is reversed. The reason for this is claimed to be the fact that

the ambiguity is resolved based on the animacy of the NPs in the sentence (Lamers, 2007). More specifically, the verb *verwonderde* ('amazed') requires an object that is able to undergo a psychological change (i.e. being amazed). Since the only referent that is capable of being amazed in the sentence is *de atleet* ('the athlete'). Therefore, no matter where the animate noun phrase is located in the sentence, it is interpreted as the object.

(34a) *De fotograaf*    *verwonderde*    *de atleet.*

the photographer    amazed    the athlete

'The photographer amazed the athlete.'

(34b) *De atleet*    *verwonderde*    *de foto.*

the athlete    amazed    the foto

'The photo amazed the athlete.'

(34c) *De foto*    *verwonderde*    *de atleet.*

the photo    amazed    the athlete

'The photo amazed the athlete.'

(Lamers, 2007)

Animacy being used as an indicator of semantic roles makes also sense under the approach that is called incremental sentence processing. This approach assumes that processing is most efficient when every piece of linguistic input (for example, the words of a sentence) is processed as soon as possible. For instance, seeing a noun in the initial position could immediately trigger a process of syntactic analysis on the basis of relevant information such as animacy, word order, case, verb agreement (depending on the language). These types of information can facilitate processing when they are combined in a congruous way (semantic roles conform with animacy cues), or slow down processing when they are combined in an

incongruous way (Bornkessel-Schlesewsky & Schlewsky, 2009, Lamers & Tiel, 2012), for example, a sentence where an animate noun is the patient and an inanimate noun is the agent of an action.

Studies using event-related potentials (ERP) have addressed the question of whether language users rely on animacy as a cue to interpret the semantic roles that nouns play in a sentence in online processing of Mandarin (Phillipp, Bornkessel-Schlesewsky, Bisang, Schlewsky, 2008) and of German (Frisch & Schlewsky, 2001; Schlewsky & Bornkessel, 2004). For instance, in German, it was shown that animacy was taken as a cue to interpret the semantic roles of the two nouns that were marked with the same case in the sentence, which creates ungrammaticality. This was suggested by the evidence coming from the comparison between two structures: In both of those structures, the case was the same on both nouns (nominative-nominative). However, in one of the structures, the animacy of the nouns differed (animate vs. inanimate) whereas in the other one, the animacy of the noun was also the same (animate vs. animate). The N400 in the latter structure suggested that the language comprehension system was unable to see one of the nouns as the subject and the other noun as the object. Nevertheless, when the two nouns differed in animacy, there was no N400 effect, suggesting that the language comprehension system overcame the ungrammaticality due to the identical case marking such that it reanalyzed the case information on the basis of the animacy nouns. This particular finding has also shown that the animacy information can override case-marking, which can be considered compatible with good-enough parsing.

Acquisition studies suggest that children also use heuristics-based animacy. Becker (2015) has shown that children not only pay attention to animacy

properties of nouns but also, they use this type of information in combining nouns with adjectives they have recently learned. Becker had children learn novel adjectives that were used with either animate or inanimate nouns by means of videos containing a dialogue between the two parties. After having watched each video, the child was supposed to answer a yes-no question. The question involved either a *tough*<sup>13</sup> question (for example, ‘Is it X to V a Y?’, where X is the novel adjective, V is a verb, and Y is a noun) or a question without a *tough* structure (‘Is Y X?’, where again X is the novel adjective and Y is a noun). Each child saw each adjective being used only with one noun. As was predicted, children categorized the novel adjectives as ‘tough’ adjectives more often if they were used with an inanimate noun. This study has suggested that even 3-year-olds used animacy as an information source in learning novel adjectives, which can be regarded as a heuristic. This is of course not surprising given that we all use animacy in sentence comprehension since it is part of interpreting linguistic input.

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<sup>13</sup> An example of a tough structure in English is: ‘This topic is easy to write about.’

CHAPTER 5  
AN INVESTIGATION OF THE ROLE OF ANIMACY  
IN SENTENCE COMPREHENSION

5.1 The research question

In the present study, I explore whether the animacy of noun phrases is used in determining their thematic roles (e.g. agent, patient) before a theta-assigner (i.e. a verb) appears. In other words, the research question is whether syntactic roles can be understood before they are syntactically specified.

The key hypothesis is that the animacy category of noun phrases (animate vs. inanimate) should make the comprehender assign a proto-theta-role to those nouns before the nouns get their theta-roles from the verb in the sentence. If this is what happens, then the implication of this would be that processing will become harder in the case where the actual theta-roles are assigned by a verb different from the proto-theta-roles assigned on the basis of animacy of the noun phrases, as compared to cases where the actual theta-roles conform to the proto-theta-roles. To make this clear, I will give two examples and talk about how animacy can be used as a predictor (although it can be helpful or deceitful) and what the implications of the use of a heuristic developed on the basis of animacy are. Let us consider the sentence<sup>14</sup> in (35) first. This sentence begins with a locally ambiguous sequence of two noun phrases (*yolcu uçağı* ‘passenger + airplane’). The sequence can be a subject-object sequence or a compound. The moment when the parser sees the noun phrase *yolcu* (‘passenger’) it would tend to see it as a potential subject because of the tendency to take the first nominative-cased noun-phrase as the subject

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<sup>14</sup> Notice that the verb is missing for simplification.

(Demiral, Schlesewsky, Bornkessel-Schlesewsky, 2008). This noun phrase is followed by the noun phrase *uçacağı* (‘airplane’), which is inanimate. The ambiguous suffix (“-I”) on this noun phrase tells the parser that this noun phrase can either be an object or part of a compound constructed with the previous noun phrase *yolcu*. Since the first noun phrase is preferred to be the subject and the second noun phrase is preferred to be a patient for being inanimate, the parser may favor the interpretation that *yolcu* is the subject and *uçacağı* is the object of the sentence. If *yolcu uçacağı* is taken to be a subject-object sequence, the comprehender would expect to see a transitive verb at the end of the sentence. Nevertheless, if the theta-assigner verb happens to be a verb that assigns only one argument (e.g. an intransitive verb, or a passive form), the parser would encounter a problem that forces it into reanalysis.

(35) *Yolcu uçacağı havaalanının arka*  
 passenger plane-LE/plane-ACC airport back  
*taraf-ın-da-ki*

side-GEN-LOC-ADJ

‘The airplane [single-argument verb] ... on the other side of the airport.’

‘The passenger [double-argument verb] ... the airplane on the other side of the airport.’

In sum, when the first noun phrase is animate, and the second noun phrase is inanimate in a sentence it will be more likely that the first one is regarded as a potential subject and the second one is regarded as a potential object. Therefore, the suffix *-I* on the second verb will be interpreted as the accusative case marker. As a result, when the verb turns out to be a single-argument verb - requiring just a subject - the parser will have to reanalyze the first interpretation and change it to the

compound reading. This reanalysis operation should manifest itself in reading times as an increase.

Let us now consider the example in (36), a sentence where the first noun phrase is inanimate, and the second noun phrase is animate. This simple change in the position of the two noun phrase is actually very crucial for the inquiry of the present study. This example also starts with an ambiguous sequence (*uçak yolcuları* ‘airplane + passengers’). As in the previous example, the parser will tend to see the first noun phrase as a potential subject, regardless of its animacy (Demiral, Schlesewsky, Bornkessel-Schlesewsky, 2008). Next, the parser processes *yolcuları*, which is animate. The ambiguous suffix (“-I”) on this noun phrase tells the parser that this noun phrase can either be an object or part of a compound constructed with the previous noun phrase *uçak*. In the case that the parser takes *yolcuları* as the object, an animate noun phrase would be assigned the theta-role ‘patient’. However, this is expected to slow down processing (Bornkessel-Schlesewsky & Schlesewsky, 2009; Lamers, 2012) as discussed in Chapter 4. Therefore, the compound reading is favored in this sentence, unlike the previous example. If the parser takes the *uçak yolcuları* sequence to be a compound, the parser would expect a verb that assigns a single theta-role. Nevertheless, if the theta-assigner verb happens to be a transitive one, the parser would encounter a problem that forces it into reanalysis.

(36) *Uçak yolcu-lar-ı havaalanı-nın*  
 plane passenger-PL-LE/passenger-PL-ACC airport-GEN  
*arka taraf-ın-da-ki*  
 back side-GEN-LOC-ADJ

‘The boarders [single-argument verb] ... on the other side of the airport.’

‘The plane [double-argument verb] ... the passengers on the other side of the airport.

To sum up, when the first noun phrase is inanimate, and the second noun phrase is animate in a sentence it will be more likely that the two noun phrases are taken to form a compound together. Therefore, the suffix *-I* on the second verb will be interpreted as a compound marker. As a result, when the verb turns out to be a transitive one requiring two arguments (i.e. a subject and an object), the parser will have to cancel the first interpretation through a reanalysis whereby it no longer regards the two noun phrases a compound formation but rather a subject-object sequence. If this takes place, we should see the cost of reanalysis in reading times, similar to the scenario where reanalysis occurs in sentence (a.)

## 5.2 The experiment

To test the role of animacy in processing ambiguous structures, I used sentences in Turkish with a local ambiguity. The local ambiguity is a product of the homophony of the accusative case marker and the nominal compound marker in Turkish, as discussed in Chapter 2. The focus of the present study is whether animacy as a predictor of semantic role (e.g. agent, patient) has an effect on parsing decisions as to ambiguous structures. To this end, I ran a self-paced reading experiment and measured reading times to find out the degree to which animacy of the noun phrases in an ambiguous sequence (for example, *çocuk kitabı* ‘child + book’) matters. If animacy may make the parser resolve the ambiguity before it is syntactically resolved, we would expect a difference between the following examples (37) in terms of the reading times spent on the disambiguating region.

(37a) *Çocuk kitabı* ..... *oku-n-du*.

child                      book-ACC                                      read-PASS-PST.3

‘The children’s book was read.’

(37b) *Çocuk kitabı* ..... *oku-muş.*

child                      book-LE                                      read-EV

‘The child read the book.’

Although both sentences begin with the same word sequence (*çocuk kitabı*), they are syntactically different. The difference results from the fact that the main verb in (37a) and (37b) differ with respect to the theta-roles they assign. In (37a), the verb *okundu* requires only a subject whereas in (37b), the verb *okumuş* requires both a subject and an object. Therefore, in sentence (37a), *çocuk kitabı* should be the subject, which means it should be understood as a nominal compound, while in sentence (37b) *çocuk* and *kitabı* are two separate units (the subject and the object, respectively). If animacy directs the parser to choose one of these readings, we would expect the same parsing preference in both sentences. However, since the ambiguous region is disambiguated differently in (37a) and (37b) by the main verb, the reading times spent on the verb should differ between the cases where the initial parsing decision made on the basis of animacy and the parsing final parsing decision made on the basis of the syntactic requirements of the verb are in conflict.

In what follows, I will talk about the experiment I have run in exploring the role of animacy and I will present the results I obtained. Before doing so, I should briefly talk about the self-paced reading paradigm as the main measurement of the experiment is the reading times on the disambiguation region.

### 5.2.1 Self-paced reading paradigm

In the experimental part of the present study, participants read sentences in Turkish at their own pace, that is, they read the sentences by their own reading speed. This task is called ‘self-paced reading paradigm’. This paradigm is widely used in psycholinguistics to measure the amount of time taken to read a word or a phrase that is presented as a stimulus in the experiment (Jegerski, 2014). Self-paced reading tasks help us examine a number of syntactic phenomena including dependency resolution, ambiguity resolution, and ungrammaticality detection.

An experiment that involves a self-paced reading task may show differences in terms of certain properties of the task, which I will discuss next, due to the researcher’s preferences or the purposes of the study. The motivation behind the use of this paradigm has its roots in the eye-mind hypothesis (Just & Carpenter, 1980), which states that the time taken to read a linguistic input should be indicating the amount of time needed to process that input. According to this hypothesis, longer reading times point out to difficulty in processing while faster reading times imply processing ease. Reading times are commonly recorded in milliseconds on the word-level. Although some researchers (i.a. Pliatsikas & Marinis, 2013; Staub & Clifton, 2011) opt for phrase-by-phrase reading because they claim it is more natural. However, the mode of presentation of the stimuli in the present study is word-by-word because it is more precise. The precision of word-by-word reading results from the fact that one can look at the amount of time taken to read each word in every sentence, which is not quite possible in phrase-by-phrase reading. Moreover, one can convert word-level reading time recordings to phrase-level reading time recordings.

In addition to the differences in how reading times are recorded in a self-paced reading task, experiments with a self-paced reading task can differ with regard to how sentences are presented. Experimental stimuli can be presented

cumulatively or non-cumulatively in a self-paced reading task. That is, each word of the sentence can appear on the screen without disappearing until the entire sentence fully unfolds (cumulative) or each word can appear and disappear before the next word appears (non-cumulative). As I am mainly interested in the differences in reading times for individual words in the present experiment, the stimuli were presented non-cumulatively so that the participants were not able to regress during reading.

Another difference that self-paced reading tasks may exhibit is where the words of a sentence appear on the screen. Because researchers are interested in reading times spent on per word in non-cumulative self-paced reading tasks every word should disappear before the next one appears. This is generally done in one of the two possible ways: 1. Each word is replaced by dashes that represent their length and position in the sentence or 2. Each word is presented at the center of the screen.

There are a number of issues that are crucial in self-paced reading experiments. Every sentence used as stimulus should be divided into regions. These regions need to be corresponding with respect to their position in the sentence. For example, if the seventh region is the target region in the structure of interest, the seventh region should be the target region in all experimental items. Each corresponding region should be identical in terms of or controlled for length and frequency (Jegerski, 2014) to make the regions comparable.

### 5.2.2 The structures used in the experiment

In the structures to be used in the present study, the following factors will be manipulated: (a) positioning of an animate and an inanimate noun phrase relative to each other (animate-inanimate vs. inanimate-animate), (b) the number of arguments

required by the main verb (one argument or two arguments). If the main verb is a single-argument verb, the complex noun phrase (the compound form) will be the subject of this verb. However, if the verb is a two-argument verb, the first two noun phrases that are likely to be taken as a compound will be reanalyzed to be a sequence of a subject and an object since the main verb requires an object. In the end, there will be 4 conditions. The structures are explained more in detail in what follows.

#### 5.2.2.1 Experimental conditions

All the items (including fillers) begin with a sequence of two noun phrases, followed by an adjunct (which is not explicitly shown for simplification). These adjuncts are used to create a more pronounced garden-path effect - if there is any - since it has been shown that increasing the distance between the ambiguous region and the disambiguating region makes the garden-path effect stronger (Christianson et al., 2001; Tabor & Hutchins, 2004). The adjuncts contain seven words and a clause across all the items. Half of the experimental items begin with an animate noun phrase that is followed by an inanimate noun phrase (e.g. *çocuk kitabı* ‘child + book’) while the other half of the experimental items begin with an inanimate noun phrase followed by an animate noun phrase (e.g. *findık fareleri* ‘hazelnut + mice’). Therefore, the manipulation concerning the animacy of the noun phrases is between items manipulation. Besides, the valency of the main verb is manipulated such that the main verb requires either one argument or two arguments. The root of the main verb is identical in the two forms of the verb that differ in valency (for example, *kiralandı* ‘it was rented’ vs. *kiralamış* ‘apparently he/she rented it’). A spillover region was added following the critical verb that will allow us to see how the dependency between the first two noun phrases and the main verb is resolved. The

spillover region should also prevent end-of-sentence wrap-up effects on the critical region. The spillover region will be in the form of the following: *yazıyor kitapta* ‘it says in the book that’, which enables the CP embedded inside it to remain intact (meaning keeping its finite morphology on the critical verb). The spillover regions are kept constant across all the items. The conditions are exemplified in (38).

(38) Conditions<sup>15</sup>

A. / A’. Animate NP1, Inanimate NP2

*Çocuk kitabı* [adjunct]      *oku-n-acak-tı* /

Child book-LE/book-ACC read-PASS-FUT-PF.3

*oku-malı-ydı* [spillover region]

read-OBLG-P.COP.3

‘The children’s book would be read.’

‘The child needed to read the book.’

B. / B’. Inanimate NP1, Animate NP2

*Fındık fareleri* [adjunct]      *zehirle-n-di* /

hazelnut mice-LE/mice-ACC poison-PASS-PST.3

*zehirle-miş* [spillover region].

poison-EV.3

‘The dormice got poisoned.’

‘The hazelnut poisoned the mice.’

#### 5.2.2.2 Baseline sentences

These items constitute a condition that is added to the two main experimental conditions. The baseline items are unambiguous versions of A’ and B’ where the first

<sup>15</sup> A and B: Sentences with a single-argument verb. A’ and B’’: Sentences with a two-argument verb.

noun phrase is pluralized with -lAr and the main verb always require two arguments since the plural marker avoids the ambiguity present in the other two experimental conditions. In other words, when the first noun phrase is pluralized, the compound meaning is not possible. This is shown in (39).

(39) Baseline examples

*Çocuk-lar*      *kitab-ı* [intervener]      *oku-malı-ydı* [spillover region].

Child-PL      book-ACC      read-OBLG-P.COP.3

‘The children needed to read the book.’

*Fındıklar*      *fareleri* [intervener]      *zehirle-miş* [spillover region].

hazelnut-PL      mice-ACC      poison-EV.3

‘The hazelnuts poisoned the mice.’

The reason why these baseline items are used is to avoid any potential confound such as the effect of the valency of the verb on the reading times spent on the critical region and the spillover region. More specifically, if there is a difference between the sentences with a two-argument verb and the baseline sentences, they might indicate that the difference is due to the fact that the first two noun phrases are ambiguous in the former but unambiguous in the latter. In the baseline sentences, the parser should be able to assign theta-roles<sup>16</sup> to the first two noun phrases more confidently. Since the theta-role assignment process takes place sooner in the baseline conditions as compared to their experimental counterparts, we can take out the amount of the reading time difference caused by the effect of the valency of the main verb on reading times.

### 5.2.3 Predictions

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<sup>16</sup> Agent and patient, respectively, across all the baseline items.

I will now explain the specific predictions that the two distinct approaches would make: 1. Heuristics are not used in processing the ambiguous structure. 2. Heuristics are used in processing the ambiguous structure

#### 5.2.3.1 Predictions under the assumption that animacy information is not used

If animacy cues do not help the parser make a decision about the ambiguous region (i.e. the first two nouns) before the disambiguating region (i.e. the main verb) arrives. That is to say, the interpretation of the ambiguous region will be made once the main verb has been processed. Therefore, the parser cannot arrive at a specific interpretation at the beginning and should keep both options open until it finds a proof that tells it how to disambiguate.

According to this approach, when the parser is to process a sentence, it should rely only on structural cues that are not strategized, meaning those cues should be always used and used in the same way by different language users. Moreover, the use of structural cues not in a strategical way predicts the same parsing behavior for the same structure. For example, although the experimental conditions in the present study differ in terms of animacy, they are identical with regard to the structural properties of the ambiguous region. The ambiguity in that region stems from the fact that Turkish employs the same suffix (i.e. *-I*) for different functions, namely, the accusative case marker, the possessive case marker, and the compound marker. As explained before, when a nominative-cased noun phrase is followed by a noun phrase that has the suffix *-I*, the combination of those two noun phrases can either be a subject-object sequence or a noun-noun compound in Turkish. Because the structural cues including word order, word category, case marking do not make the parser go for a single interpretation of the ambiguous

region, it should wait until something that helps it disambiguate comes up. In the present study, the disambiguating element is the main verb that appears at the end of the sentence (ignoring the spillover region). As disambiguation occurs on the main verb, there might be an increase in reading times due to the retrieval and the interpretation process concerning the part of the sentence to be disambiguated (i.e. the first two noun phrases). By the time the parser processes the main verb, it should retrieve the first two noun phrases and assign them (a) theta-role(s). If the main verb is a single-argument verb then the retrieved noun phrases should be taken to be a compound since the main verb requires only one argument, which is the subject. If the main verb is a two-argument verb, then the noun phrases that constitute the ambiguous regions should be the combination of the subject and the object. As the first noun phrase is the one that has the nominative case it has to be the subject. Similarly, as the second noun phrase is the one that has the accusative case it has to be the direct object. Since the number of the theta-roles assigned after the retrieval of the first two noun phrases differ between when the main verb is a single-argument verb and when the main verb is a two-argument verb, there might be an effect of valency on the reading times spent on the main verb and the following word assuming that assigning two theta-roles is a heavier operation than assigning a single theta-role. However, resolving the ambiguity upon processing the main verb does not have any implications for the accuracy or the response times in answering the comprehension questions.

### 5.2.3.2 Predictions under the assumption that animacy information is used

When the parser sees a noun phrase at the beginning of a sentence in Turkish, it is more likely that the parser takes that noun phrase as a potential subject regardless of

the animacy of the noun due to the subject preference (Demiral et al., 2008). Moreover, it is claimed that animate noun phrases are good agents and experiencers and that since subjects are often agents and experiencers it is expected that most subjects are animate (as discussed by Primus, 1999). In the cases where the first noun phrase is animate, this noun phrase should receive a proto-agent role. In contrast, in the cases where the first noun is inanimate, this noun phrase should receive a proto-patient role. When the parser processes the second noun phrase, which differs from the first one in animacy in all the experimental conditions, that noun phrase should also get a proto-theta-role on the basis of its animacy. That is inanimate noun phrases get a proto-patient role and animate noun phrases get a proto-agent role (40).

(40) Proto-theta-roles based on animacy

(i) NP1: animate      NP2: inanimate

proto-agent              proto-patient

(ii) NP2: inanimate    NP1: animate

proto-patient            proto-agent

As soon as the second noun phrase is processed and the proto-theta-roles are assigned to the first and second noun phrase, the parser checks to see if any update regarding these decisions is necessary. To this end, the parser takes other cues into account. For instance, the second noun phrase has always the suffix *-I* on it. As explained in Chapter 2, this suffix in Turkish is ambiguous such that it can either be the accusative case marker or a compound marker. The decision about this suffix should be made in accordance with the animacy of the noun phrases. When the first noun phrase is animate and the second phrase is inanimate, taking the suffix to be the accusative case marker is compatible with the proto-theta-roles. This is because of the fact that the accusative case marker indicates that the noun phrase that has it is

the theme or the patient that is being affected by the action or event mentioned in the sentence. Since inanimate noun phrases are better candidates for being an object, the suffix *-I* attached to an inanimate noun phrase should be regarded as the accusative case marker. However, the situation is different when the alignment of the animate and the inanimate noun phrases changes. When the first noun phrase that is inanimate is followed by an animate noun phrase marked with *-I*, it can be costly for the parser to regard this suffix as the accusative case marker since inanimate noun phrase being the doer and the animate noun phrase being the recipient would a disharmonic parse (as discussed by Primus, 2012, p. 22). Therefore, instead of taking it to be the accusative case marker, the parser is more likely to treat the suffix as a compound marker. As a result, the two noun phrases would make up a complex noun phrase that behaves as a single syntactic unit. Hence, the use of heuristics has two different implications for the two constellations with the different alignments of the animate and the inanimate noun phrase, which is summarized in (41).

(41) Implications of the use of animacy for the interpretation

NP1: animate	NP2: inanimate	Suffix
proto-agent	proto-patient	ACC marker
NP2: inanimate	NP1: animate	Suffix
proto-patient	proto-agent	Compound marker
Animate-Inanimate > subject-object sequence		
Inanimate-animate > compound		

If the parser is more likely to take a sequence of an animate and an inanimate noun phrase as a subject-object sequence, it is also more likely that the parser expects a verb that denotes an event taking place between two parties (i.e. subject and object). Likewise, if the parser is more likely to take a sequence of an

inanimate and an animate noun phrase as a compound, then it is more likely that the parser expects a single-argument verb on the contrary to the other constellation. As the parsing decisions made regarding the ambiguous part of the sentence yield different structures, the parser anticipates what is coming up in the rest of the sentence differently. For example, when the parser takes the ambiguous region to be a subject-object sequence, a two-argument verb that links the subject to the object is expected. If the main verb that disambiguates the ambiguous region turns out to be an intransitive verb, that will tell the parser that the ambiguous regions is not a subject-object region but a compound, which will be a reanalysis process. As for the case when the parser takes the ambiguous region to be a compound, a single-argument verb is needed because there should not be any second party that is being affected by the event on the basis of the preliminary interpretation made by using the animacy cues. As there is nothing else that suggests otherwise, the parser clings to this interpretation until the disambiguating regions (i.e. the main verb) arrives. If the main verb is a single-argument verb, everything should be okay. However, when the verb turns out to be a double-argument verb, a reanalysis process should be triggered, such that the compound interpretation is cancelled and replaced by the interpretation that the first two noun phrases are actually a subject-object sequence.

In the cases where reanalysis takes places, there should be an increase in the reading times spent on the critical word (i.e. the main verb) or on the spillover region. I hypothesize that the most pronounced effect of the use of heuristics, if there is any, will manifest itself in reading times. When a sequence of two noun phrases is predicted to form a compound but they turn out to be a subject-object sequence, this should trigger reanalysis, which will possibly cause a slowdown in reading the disambiguation region and the spillover region. As the comprehension questions are

more of trivial ones and are not controlled for their types across the conditions, they will just serve as a sign showing if the participant paid enough attention to the stimuli. What is more, answers given to the comprehension question cannot show how the participant interpreted the ambiguous structure since the comprehension question do not ask specifically about that part of the sentence. Therefore, the focus of the analysis will be the reading times, especially on the critical region and the spillover region that follows it because it is the main verb (i.e. the critical regions) that unambiguously tells what the structure of the ambiguous part of the sentence really was. These predictions are summarized in (42).

(42) Predictions when animacy information is used

(i) NP1: animate	NP2: inanimate	Expected Argument #
proto-agent	proto-patient	Double
(ii) NP2: inanimate	NP1: animate	Expected Argument #
proto-patient	proto-agent	Single

Reading Times:

AI as subject-object < AI as compound

IA as subject-object > IA as compound

## 5.2.4 Method

### 5.2.4.1 Participants

98 participants took part in the experiment. The average age of the participants was 22,1. They were reached out to via social media.

### 5.2.4.2 Materials

The structure of the experimental sentences used in the current experiment has already been described before. I will now provide more details about the experimental sentences as well as the filler sentences that accompanied the experimental sentences.

#### 5.2.4.2.1 Experimental Sentences

64 of the sentences from the experimental items pool were selected by means of a plausibility task. The plausibility task was carried out in order to see whether the items were more or less the same with respect to their plausibility, which can in principle influence how difficult it is to understand the sentences. The difficulty that is due to the implausibility of the sentence is expected to increase the reading times for the sentence, which will add to the increased reading time that is due to the sentence being a garden-path structure. Hence, plausibility is a potential confound that needs to be controlled. 12 master's students from the Department of Linguistics at Boğaziçi University took part in the pre-study. Each participant saw one of the three versions of the experimental items and rated them with respect to how plausible they thought the sentences were on a 5-point Likert scale (1: very implausible, 5: very plausible). The items that got a score above 4 over 5 were selected (N= 64) as the experimental items. The average plausibility rating for all versions of the experimental items was 4.80. This indicates that the experimental sentences were fairly plausible. There does not seem to be much of a difference between the conditions in terms of plausibility, either. The one-argument sentences got a score of 4.82, the two-argument sentences got a score of 4.80, and the baseline sentences got a score of 4.78.

All the experimental items and the fillers consisted of twelve words. The template of the items is shown in Table 1. In between the regions of interest, there is always an intervening region that is an adjunct. All the intervener regions include a verb and consist of seven words, which serves the purpose of keeping the complexity and the length more or less the same across all the items. The main verb, which is the critical region, is always the tenth word in the sentence. The length of the main verb in terms of letters vary between the items, however, it does not differ within each item (that is the number of letters that the main verb has is fixed between the versions of the same verb).

Table 1. The Template of the Experimental Sentences and the Fillers

Region	NP1	NP2	Intervener	Main verb	Spillover
Word #	1	2	3-9	10	11-12

There was a spillover region consisting of two words at the end of every item (including fillers), which is in the form of the following: *yazıyor kitapta* ('it says in the book that'). This spillover region allows the main analysis of the reading times, which will show the effect of the transitivity of the main verb. It should be noted that the word order of the spillover region is non-canonical. This is because the noun *kitapta* would be at the beginning of the entire sentence and the verb would be at the very end in the canonical word order, which creates a very long-distance dependency. To avoid this, I preferred the non-canonical word order in the spillover region. Given that the spillover region is kept constant across the board, the effect of non-canonical word order in the spillover region should be minimized.

#### 5.2.4.2.2 Questions

Each sentence in the experiment (including fillers) was followed by a comprehension question in the form of *Cümlede hangisinden bahsedildi?* ('Which one of the following was mentioned in the sentence?') along with two options (one was mentioned in the sentence, the other was not). Participants were required to choose the option that was mentioned in the sentence they had just read. The reason why these comprehension questions were used is to make participants pay attention to all the regions of the sentence to approximately the same degree. Therefore, the options accompanying the questions were asking about any part of the sentence, which is randomized across the items. The options were designed in a way that the experiment was supposed to seem to be about the meaning of the words read in the sentence. To this end, the options were written in the following way: One of the words mentioned in every sentence was randomly chosen, which always made up the correct answer across all the items. The incorrect answers were one of the following: a synonym or a near synonym of the correct answer (for example, *university* vs. *college*), an antonym of the correct answer (for example, *happiness* vs. *sadness*), something that is from the same semantic domain (for example, *car* vs. *bus*). The word from the sentence that was being asked about could be any of the twelve words in the sentence. The options included both nouns and verbs. The order of the correct answer was randomized.

In order for participants to be able to decide what was mentioned in the sentence, it is not essential for them to do compute deep-level computations. Rather, they just needed to decide whether they had read the word in the sentence. Nevertheless, if participants were willing to give accurate answers to the comprehension questions, they needed to pay a fair amount of attention to each word

in the sentence. It should also be noted that the comprehension questions were all trivial questions with the simple aim to motivate participants to read the sentences properly. The main aim was not to make participants contemplate the purpose of the study. As it is claimed that experimental settings might make participants treat stimuli differently than usual linguistic input by possibly forcing them to study the structures used in the experiment to get a single, fully developed meaning (Ferreira et al. 2002), I tried to keep the demands of the task at minimum such that it did not necessarily make participants develop further strategies to resolve the ambiguity.

#### 5.2.4.2.3 Fillers

The fillers were designed in a way that participants should not be able to understand what the experiment is after (e.g. ambiguity, the animacy of the noun phrases). Half of the fillers begin with two consecutive animate noun phrases, whereas the other half begin with two consecutive inanimate noun phrases.

#### 5.2.4.3 Procedure

The experiment was administered on Ibex Farm<sup>17</sup>, which is a platform to run Internet-based experiments. Participants took part by clicking a link that was shared on social media. All participants were run in the environment of their preference. They were first briefly informed about the procedure. Then, they indicated that they consented to participate in the experiment. They were also asked to state if they were a native speaker of Turkish and if they were a college student. They were also asked to indicate their age. Participants were told that they would be able to withdraw from participation at any point in the experiment.

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<sup>17</sup> <http://spellout.net/ibexfarm>

After they went through the introductory part of the experiment, they were instructed as to how the experiment would go. Then, they read four practice items and answered the related comprehension questions for them to get familiarized with the procedure. If they answered a comprehension question incorrectly, an error message appeared on the screen to motivate them to pay more attention (only in the practice items). Having finished reading the practice items, participants proceeded to the actual experiment. Participants read only one of the three versions of every experimental item. These versions were randomly assigned to participants by the web platform. The fillers were the same for all participants. Participants read each sentence on their own pace in a word-by-word manner by pressing the SPACE BAR on their keyboard (more detail about this task will be provided in the next section ‘self-paced reading paradigm). Each sentence was followed by the same question ‘*Cümlede hangisinden bahsedildi?*’ (Which one of the following was mentioned in the sentence?) along with two options (one was mentioned in the sentence, the other was not). These options were given a number (1 or 2). Participants were required to choose the right answer by pressing 1 or 2, depending on what they thought was the right one. The order of the right and wrong answer was randomized across the board. Unlike the sentences, the questions and their options were presented as a whole on the screen after participants pressed SPACE BAR at the end of each sentence. The reading times spent on each word of every sentence were recorded. The responses given to the comprehension questions and the response times were also recorded. An experimental session took around 30 minutes to complete.

## CHAPTER 6

### FINDINGS AND THEIR IMPLICATIONS

#### 6.1 Results and discussion

The analyses of the data collected in the experiment were analyzed using a statistics software called R (R Core Team, 2018). The average accuracy rate was measured for every participant ( $M = 95\%$ ) and every item ( $M = 95\%$ ). The accuracy rates were fairly high both on the participant- and the item-level. However, one of the participant's data were excluded from the analyses due to their low accuracy (65%) in answering the comprehension questions, which suggests that that participant did not pay enough attention to read the sentences presented in the experiment. The participant who has the second-lowest accuracy rate got a score of 82%. Therefore, no other participant was excluded from the analyses.

Before conducting the analyses, the reading times spent on the relevant regions that were exceptionally low ( $< 80\ ms$ ) and exceptionally high ( $> 6000\ ms$ ) were also excluded. Generalized-linear models were fit to reading times with the package called 'brms' (Bürkner, 2017; 2018). I fit the models with four chains and 2000 iterations (half of them were the warm-up phase). These models were hierarchically fit models on the log-normally distributed errors, with by-participant and by-item random effects. In the models that included valency (single-argument, two-argument, and baseline) as a fixed effect, Helmert contrasts were used. The estimates gotten from the brms models were in the log-scales, however, they were transformed into reading times in milliseconds for making interpretation easier.

### 6.1.1 Reading times in the critical region

The analysis of the reading times spent on the critical region (i.e. the main verb) shows that there is no significant difference between the conditions in terms of the average RTs (Figure 1). Nevertheless, there seems to be a trend whereby the reading times are relatively higher in the two-argument sentences (i.e. valency: double) than in the baseline sentences and in the single-argument sentences (i.e. valency: single). The slight difference between the baseline sentences and the two-arguments sentences is interesting given that the only difference between these conditions is that the first noun phrase is a plural form in the baseline sentences, hindering the compound reading (as in *hastalar yemeği* ‘patients + meal’). Therefore, the trend where the two-argument sentences were read slightly slower than the baseline sentences cannot be attributed to the effect of the transitivity of the main verb. This trend may imply that the first noun phrase was more often interpreted as the subject and the second phrase was more often interpreted as the object in the baseline sentences than in the two-argument sentences. This finding may be due to the fact that there is only one interpretation of the sequence of the two noun phrases at the beginning of the baseline sentences whereas there are two interpretations of the sequence of the two noun phrases at the beginning of the two-argument sentences, in other words, the sequence of the two noun phrases at the beginning of the baseline sentences do not constitute an ambiguous string while the sequence of the two noun phrases at the beginning of the two-argument sentences makes up an ambiguous string.

In sum, it looks as though the animacy information of the noun phrases in the ambiguous region had an effect on the reading times spent on the

critical region (i.e. main verb). However, this trend does not seem like a significant effect by looking at the error bars (Figure 1).

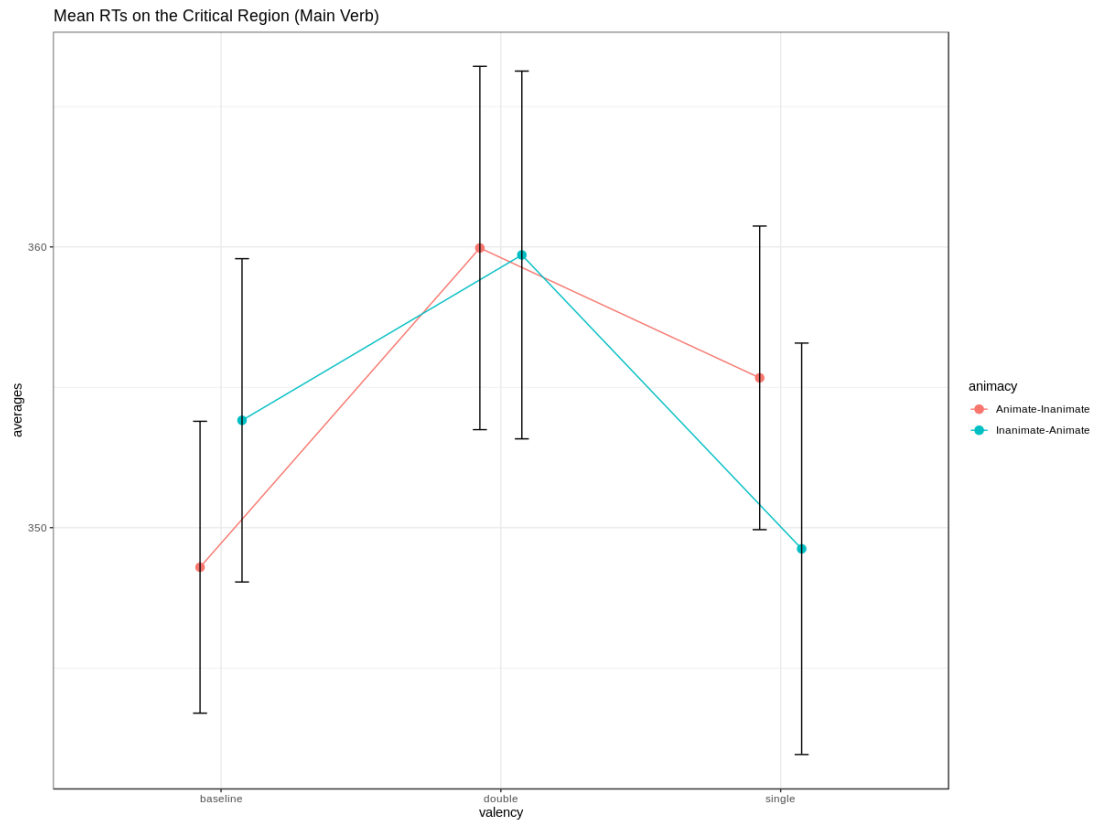


Figure 1. Average reading times in the critical region <sup>18</sup>

The model of the RTs on the critical region (the main verb) revealed no effects of the experimental manipulations, namely the animacy of the noun phrases (animate-inanimate vs. inanimate-animate) and the valency of the main verb (single-argument vs. two-argument verbs), as shown in Table 2. The results of the model are indicated in the table as reading times (milliseconds). To calculate the reading times, the estimates in the log-scale were transformed into milliseconds by exponentiating the estimate values.

<sup>18</sup> The bars represent standard errors.

Table 2. The Results of the Model of the RTs on the Critical Region with the Predictors Valency and Animacy<sup>19</sup>

	Mean	Lower	Upper
Intercept	320.865	301.133	341.938
Valency: double	1.015	0.978	1.051
Valency: single	1.017	0.982	1.053
Animacy: Inanimate- Animate	1.007	0.976	1.041
Valency: double, Animacy: inanimate-animate	0.986	0.939	1.034
Valency: single, Animacy: Inanimate- Animate	0.965	0.921	1.013

Looking at the results obtained at the critical region, I argue that it is slightly easier to resolve the dependency between the subject and the verb when the subject and the verb are unambiguously determined early in the sentence (i.e. the baseline conditions). The slight difference between the sentences with a single-argument verb and the sentences with a two-argument verb may have been due to

<sup>19</sup> The reading times are indicated in milliseconds.

their being different in terms of the numbers of argument they require. In other words, assigning two theta-roles to the two nouns separately could have taken more time than assigning a single theta-role to the whole complex noun phrase.

### 6.1.2 Reading times in the spillover region 1

There seems to be a difference in the baseline condition in the RTs in the first word (i.e. *yazıyor* ‘it is written’) of the spillover region between the sentences beginning with an animate-inanimate and the sentences beginning with an inanimate-animate sequence (Figure 2).

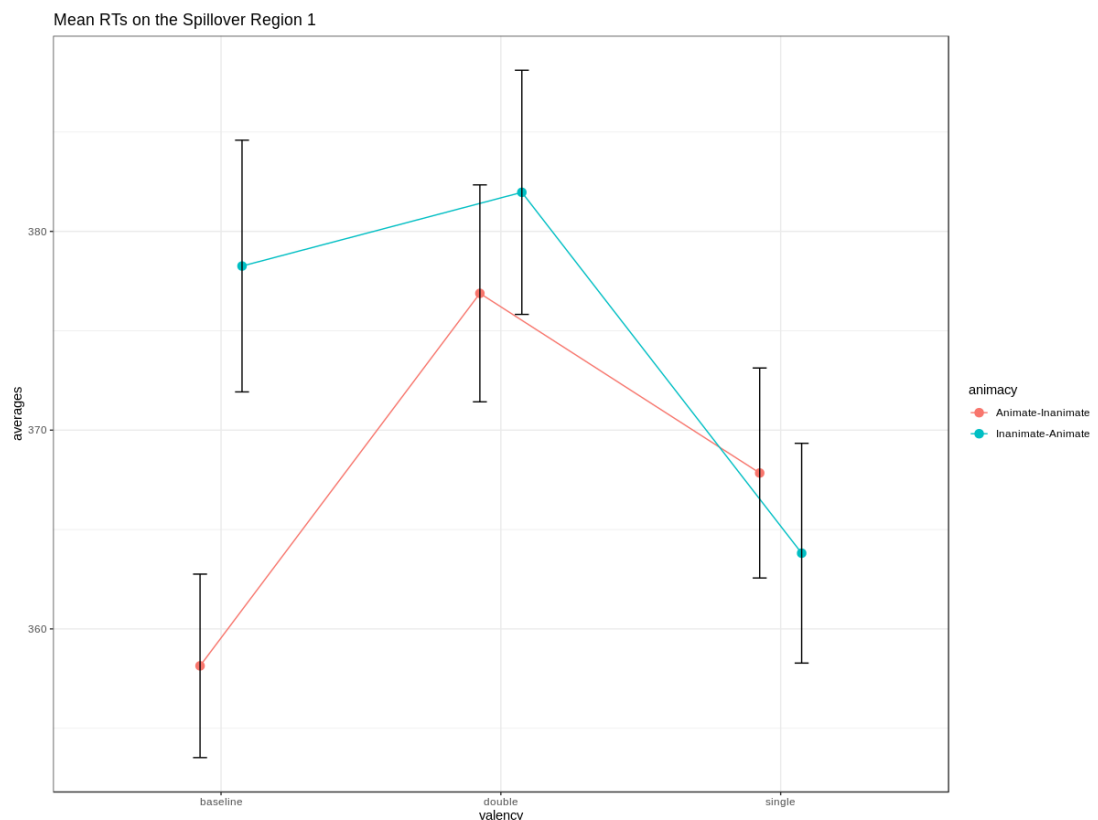


Figure 2. Mean RTs in the spillover region 1

The average RTs in this region indicates that the IA sentences were read slower than the AI sentences in the baseline condition. There is also a difference between the AI

sentences in the baseline condition and the two-argument conditions in terms of the average RTs while the AI sentences in the single-argument condition do not differ from the two-argument condition and barely significantly differs from the baseline condition. The only difference between the IA sentences is the one between the IA sentences in the two-argument condition and the IA sentences in the single-argument condition. The IA sentences in the two-argument condition were read slower than the IA sentences in the single-argument condition ( $\beta = -0.049$ , CrI: [-0.098, -0.001]) as shown in Table 3.

Table 3. The Results of the Model of the RTs on the First Word of the Spillover Region with the Predictors Valency and Animacy

	Mean	Lower	Upper
Intercept	332.485	313.719	352.482
Valency: double	1.034	1.001	1.066
Valency: single	1.024	0.992	1.057
Animacy: inanimate-animate	1.034	1.003	1.066
Valency: double, Animacy: inanimate-animate	0.978	0.933	1.026
Valency: single, Animacy: inanimate-animate	0.951	0.908	0.998

If we compare the RTs in this region to the ones in the previous region (i.e. the critical region), we see that there is an overall increase in the RTs in the spillover region. However, the highest increase is in the sentences with an IA sequence in the baseline condition. The increase is so high that the insignificant difference in RTs between the AI sentences and IA sentences in the previous region becomes significant here. This finding is interesting because although the first two noun phrases should be unambiguously interpreted as the subject and the object (respectively) of the sentence, it seems that an inanimate noun phrase interpreted as the subject and an animate noun phrase interpreted as the object causes some trouble to the comprehender. However, when the first noun phrase that is animate and the second noun phrase that is inanimate are unambiguously interpreted as the subject and the object (respectively) of the sentence, processing was substantially faster than the two-argument version of the same sentence as can be seen from the difference between the AI sentences in the baseline condition and the AI sentences in the two-argument condition (Figure 2) despite the main verb being the same in these conditions.

### 6.1.3 Reading times in the spillover region 2

The only significant difference in the RTs on the second word of the spillover region (i.e. *kitapta* ‘in the book’) is between the IA sentences in the two-argument sentences and the IA sentences in the single-argument sentences (Figure 3). However, there is no significant difference between the AI sentences in the two-argument condition and the single-argument condition. Taking these two findings together into consideration, I would argue that animacy may have played a role. Let us consider the examples in (44). Notice that both examples begin with a sequence of two noun

phrases of which the first one (*orman* ‘forest’) is inanimate and the second one (*bekçileri* ‘watches’). The main verbs of these sentences are very similar, nevertheless, the one in (44a) requires a single argument (i.e. a subject) and the one in (44b) requires two arguments (i.e. a subject and an object). As a result, the interpretation of the sequence *orman bekçileri* is different in (44a) and (44b). In (44a), *orman bekçileri* (‘rangers’) is the subject whereas in (44b), *orman* (‘forest’) is the subject. Therefore, the subject in (44a) denotes an animate entity or entities while the subject in (44b) denotes an inanimate entity.

(44a) *Orman bekçi-ler-i* [intervener]<sup>20</sup> *ürper-iyor-muş.*  
 forest watch-PL-LE shiver-PROG-EV  
 ‘The rangers were shivering.’

(44b) *Orman bekçi-ler-i* [intervener] *ürper-t-iyor-du.*  
 forest watch-PL-ACC shiver-CAUS-PROG-PST  
 ‘The forest was giving the rangers chills.’

The higher reading times in the spillover region of the sentences like (44b) as compared to the sentences like (44a), therefore, can be a result of the fact that an inanimate noun phrase being a subject is considered to be a less likely event by the parser than an animate noun phrase being a subject.

I would like to clarify a point about (44b). Although it is possible to have an object-drop reading in sentences with a causative verb in Turkish such that the sequence of the two noun phrases is the subject and the object is not mentioned, it is not possible to have it in (44b). The object-drop reading in causative structures is only possible with verbs whose agent is easily predicted, such as *kestir-* ‘to have cut’. For example, in an utterance like “*Saçımı kestirdim.*” ‘I had my hair cut.’, the action

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<sup>20</sup> The intervening regions is not explicitly shown in the examples for the matter of simplicity.

of cutting is highly likely performed by a hairdresser. However, the object-drop reading should not be possible with psych-verbs that are causative forms (e.g. *korkut-*, ‘to scare’, *ağlat-* ‘to make cry’, *güldür-*, ‘to make laugh’). Therefore, the reading where *orman bekçileri* is the subject and there is an unspecified object should not be possible with the verb *ürpert-*, which is also a psych-verb, in (44b).

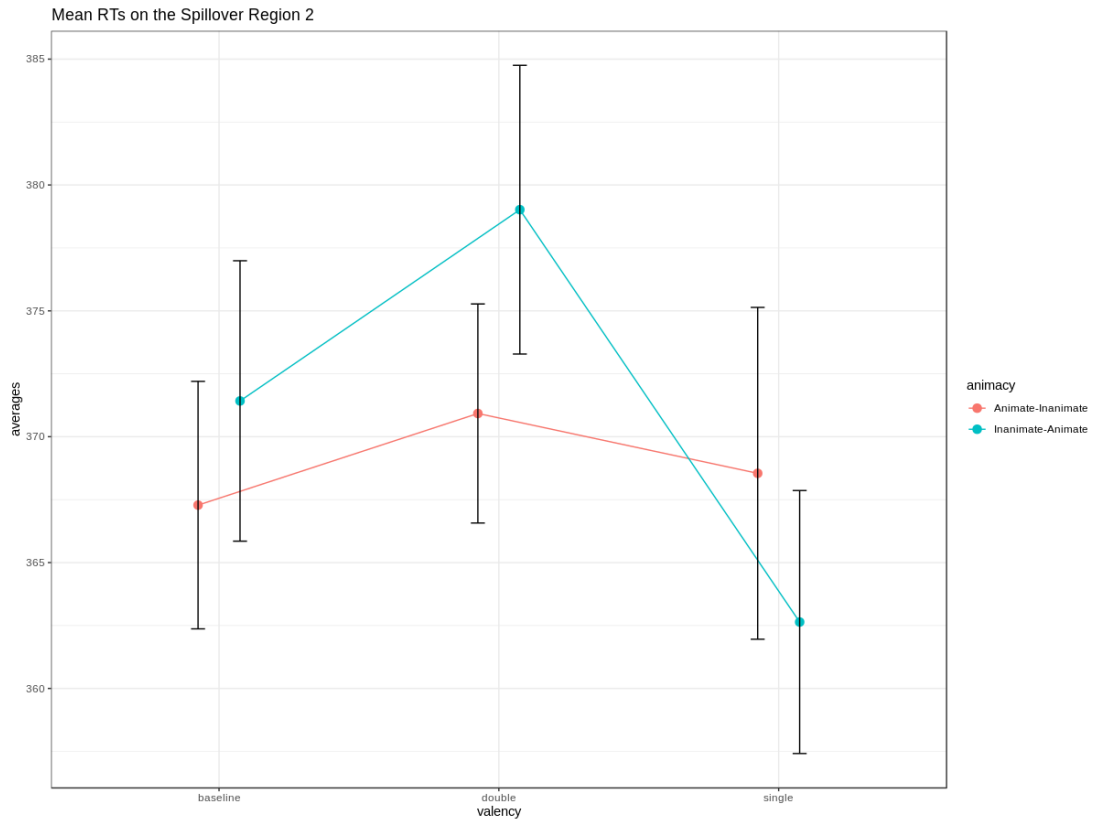


Figure 3. Average reading times on the second word of the spillover region

As the plot in Figure 3 indicates, the only significant difference in the RTs on the second word of the spillover region (i.e. *kitabta* ‘in the book’) is between the IA sentences in the two-argument sentences and the IA sentences in the single-argument sentences. To measure this effect, a model of the reading times on the second word of the spillover region with the predictors valency and animacy was run.

Table 4. The Results of the Model of the RTs on the Second Word of the Spillover Region with the Predictors Valency and Animacy

	Mean	Lower	Upper
Intercept	344.818	328.380	362.166
Valency: double	1.015	0.989	1.041
Valency: single	0.995	0.971	1.022
Animacy: inanimate-animate	1.007	0.981	1.033
Valency: double, Animacy: inanimate-animate	1.001	0.963	1.041
Valency: single, Animacy: inanimate-animate	0.982	0.945	1.020

#### 6.1.4 Reading times on the first word

In order to see if there is any difference in the RTs caused by the difference in animacy at the beginning of the sentence, the RTs on the first word were analyzed. There is no significant difference between animate noun phrases and inanimate noun phrases at the beginning of the sentences with respect to RTs. (Figure 4 and Table 5). Although there seems to be a trend where the inanimate noun phrases at the beginning of the sentence were read slower than the animate noun phrases at the beginning of the sentence, the difference is very tiny.

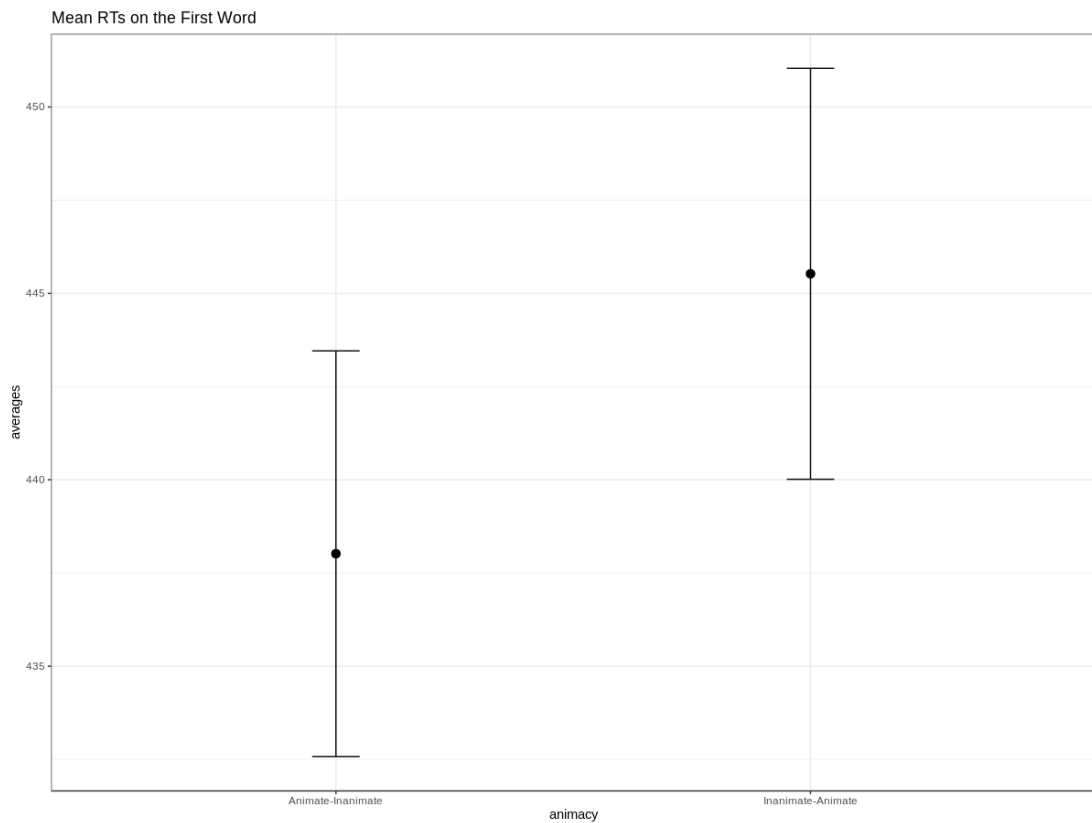


Figure 4. Average reading times on the first word of the sentence

Table 5. The Results of the Model of the RTs on the First Word of the Sentence with the Predictor Animacy

	Mean	Lower	Upper
Intercept	385.983	364.419	406.624
Animacy: inanimate-animate	1.018	0.997	1.038

#### 6.1.5 Reading times on the second word

The RTs on the second word were also analyzed to see if the animacy of the noun phrase in this region has an effect on the time needed to process this word. The RTs were found to be almost identical for this region across the board (Figure 5), and

there is not a significant difference between the second words of the animate-inanimate and inanimate-animate constellations in terms of reading times (Table 6). Therefore, it can be said that the animacy of the second noun phrase does not affect the RTs here.

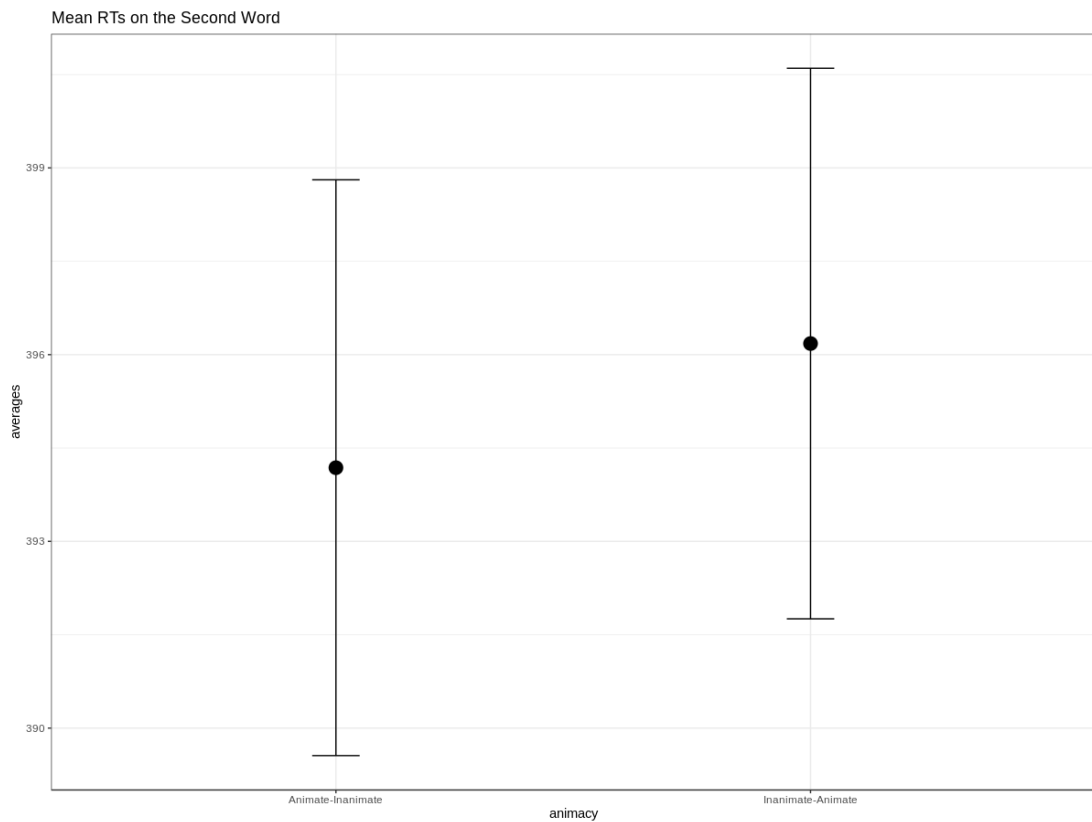


Figure 5. Average reading times on the second word of the sentence

Table 6. The Results of the Model of the RTs on the Second Word of the Sentence with the Predictor Animacy

	Mean	Lower	Upper
Intercept	351.066	330.445	374.713
Animacy: inanimate-animate	1.006	0.985	1.025

As stated in the predictions explained in Chapter 5, there is no specific prediction as to the RTs on the second and the third word, some post hoc analyses were performed in addition to the main analyses described above.

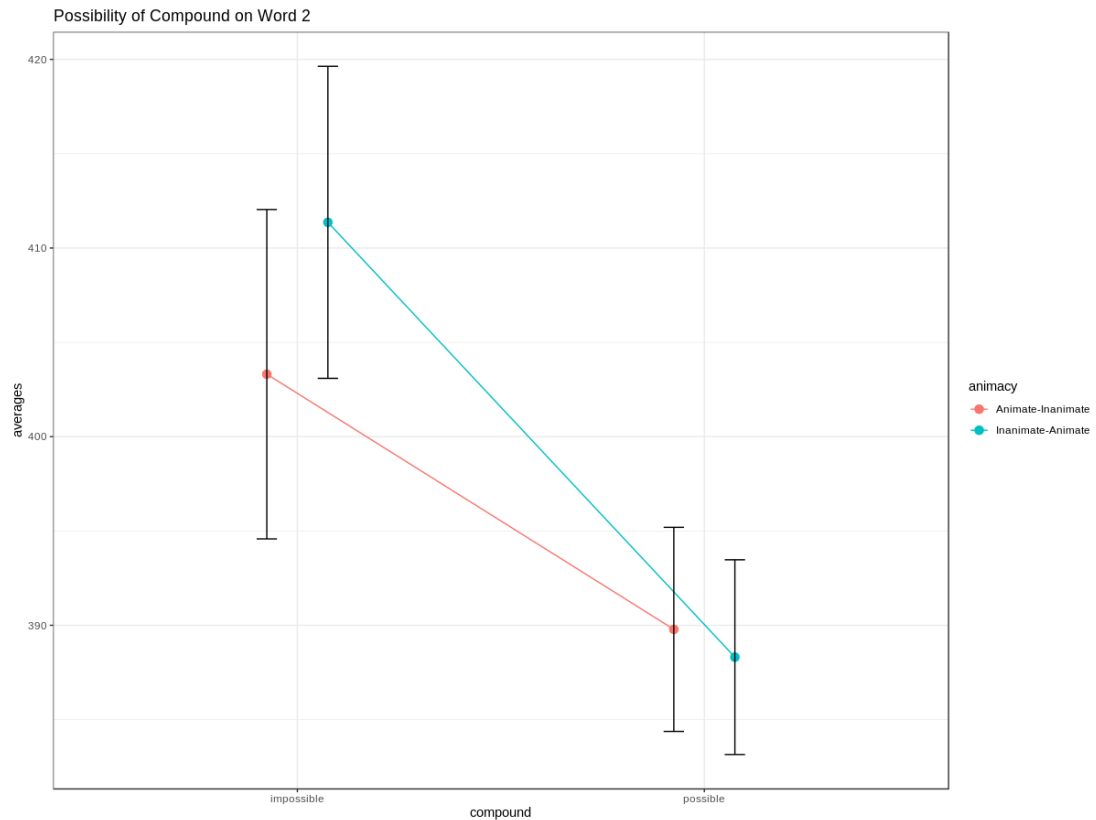


Figure 6. Comparison between cases where compounding is possible and impossible on the second word

The experimental sentences were analyzed with regard to the RTs spent on the second word to see whether there is a difference between the cases where the two nouns can form a compound (as in the single-argument and the two-argument conditions) and the cases where they cannot form a compound due to the existence of a plural marker on the first noun (for example, *hastalar yemeği* ‘patient + meal’ as in the baseline conditions). It appears that the second word of the sentence was read faster when the NP sequence can form a compound than when the NP sequence cannot form a compound (as in the baseline sentences) as shown in Figure 6.

Moreover, there seems to be no difference between the animate-inanimate and inanimate-animate constellations in terms of the reading times spent on the second word when the NP sequence can form a compound (Table 7).

Table 7. The Results of the Model of the RTs on the Second Word of the Sentence with the Predictors Compound-Possibility and Animacy

	Mean	Lower	Upper
Intercept	355.523	333.894	377.420
Compound: possible	0.980	0.955	1.008
Animacy: inanimate-animate	1.017	0.984	1.050
Compound: possible, Animacy: inanimate-animate	0.982	0.944	1.022

#### 6.1.6 Reading times on the third word

Although there is no significant difference between the AI conditions and the IA conditions in the RTs on the first and the second word, there seems to be a tiny difference on the third word (Figure 7). However, this finding cannot be taken too seriously because of the fact that the third word, the region that follows the two nouns at the beginning, was not controlled for factors like syntactic role, semantic content, predictability, and length.

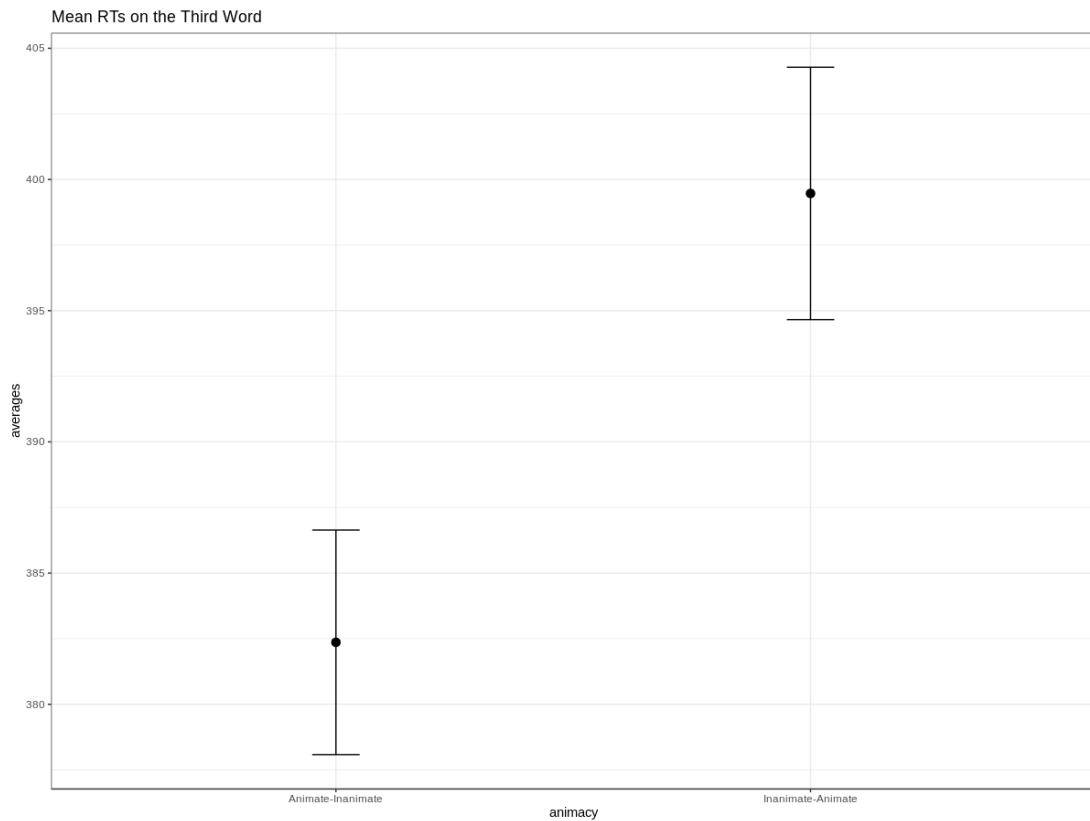


Figure 7. Average reading times on the third word of the sentence

Similar to the analysis of the RTs on the second word with respect to compound possibility, the experimental sentences were also analyzed with regard to the RTs spent on the third word to see whether there is a difference between the cases where the two nouns can form a compound (as in the single-argument and the two-argument conditions) and the cases where they cannot form a compound. It appears that there is a big difference between the third word of the inanimate-animate sentences were read significantly slower than the third word of other sentences (Figure 8). Although the third word was not controlled for factors like length, syntactic function, predictability, I would still argue that the third word of the inanimate-animate sentences in the cases where compounding should not be possible was read significantly slower given that there is systematic difference in terms of those factors and the size of the effect. Therefore, I interpret this difference as an

indicator of the fact that an inanimate-animate sequence causes processing difficulty for the comprehender when the two nouns in the sequence are unable to form a compound. This may suggest that comprehenders often try to see an inanimate-animate sequence as a compound while they do not do this with animate-inanimate compounds.

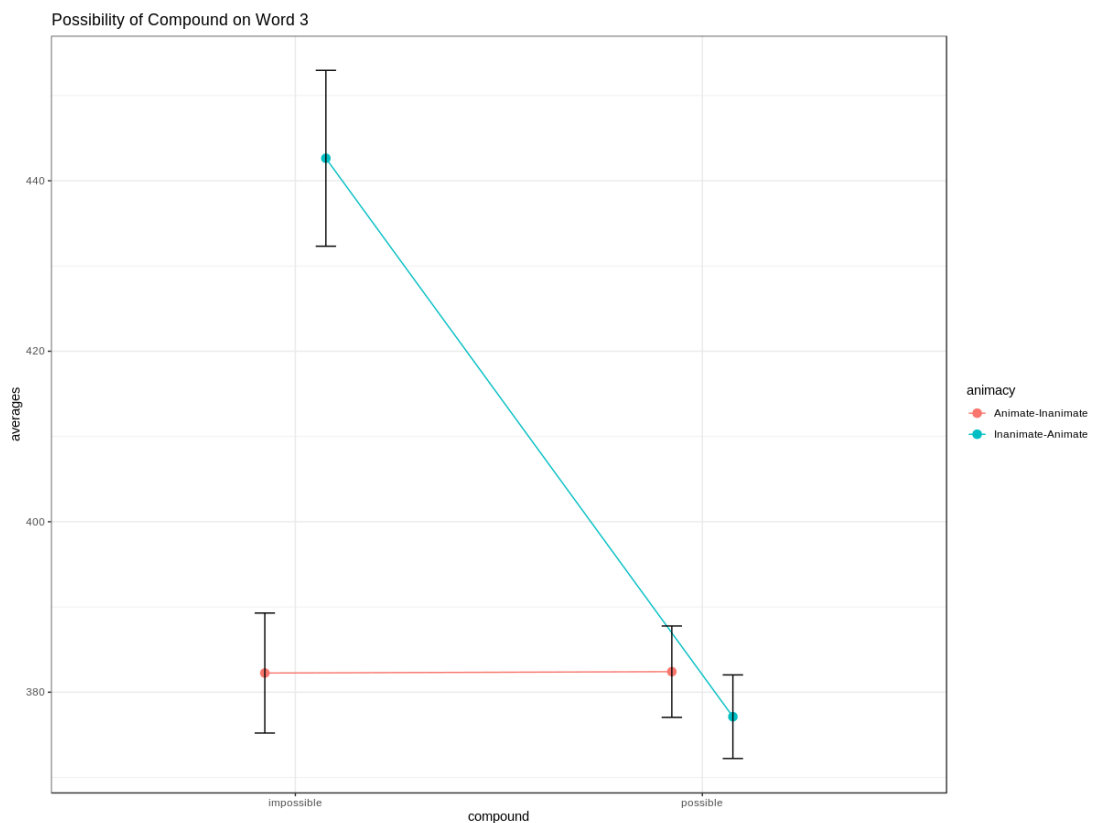


Figure 8. Comparison between cases where compounding is possible and impossible on the third word

Although the picture is fairly clear in the plot of the reading times, those reading times were also modelled with respect to the predictors compound-possibility and animacy. I did not use re-run the model with other predictors such as word length and word frequency because there are no systematic differences with respect to these factors on the third word.

Table 8. The Results of the Model of the RTs on the Third Word of the Sentence with the Predictors Compound-Possibility and Animacy

	Mean	Lower	Upper
Intercept	354.603	331.623	378.418
Compound: possible	0.979	0.951	1.007
Animacy: IA	1.014	0.980	1.050
Compound: possible - Animacy: IA	0.984	0.944	1.025

## 6.2 Summary

The analysis of the RTs in the critical region (i.e. the main verb) did not reveal any significant results with respect to the experimental manipulations (i.e. animacy and valency). Yet, the sentences with a two-argument verb were found to be read relatively slower than in the baseline conditions, which actually had the same verbs. Since the main verbs are the same in the two-argument verb conditions and the baseline conditions, it can be claimed that an unambiguous string of two noun phrases may have been retrieved relatively easily than an ambiguous string of two noun phrases, regardless of their animacy properties.

The analysis of the RTs in the spillover region (i.e. *yazıyor* ‘it is written’) indicated an overall increase in the RTs compared to the critical region, to varying degrees. The highest increase in the RTs was found in the baseline condition where the IA sentences were read slower than the AI sentences in the baseline

condition. Besides, the IA sentences were read significantly slower in the baseline condition (where the inanimate noun phrase was the subject) than in the single-argument condition (where the animate noun phrase was the subject). This can be taken as a result of the argument requirements of the verb, which may result in increased RTs for the cases where two theta-roles are assigned as compared to one theta-role. However, this does not hold true because of the fact that the AI sentences in the baseline condition was read relatively faster than the AI sentences in the single-argument condition. This difference can be due to the fact that the subject in the AI-baseline condition, was the animate noun phrase whereas in the AI-single-argument condition, the inanimate noun phrase (i.e. the head of the compound) was the subject. In sum, the analysis of the RTs in the spillover region suggests that an inanimate noun phrase being the subject causes a problem for the comprehender more often than an animate noun phrase being the subject. On the second word of the spillover region, all the differences disappear except for the one that indicates that this word was read slower when the inanimate noun phrase was the subject than when the inanimate noun phrase was the first word (i.e. the modifier) of a compound.

The animacy of the noun phrases was not found to substantially affect the time to process those noun phrases. However, the analysis of the RTs in the third region revealed an interaction between the animacy of the two noun phrases at the beginning of the sentence and the possibility of those two nouns being able to form a compound (the noun phrases in the baseline condition cannot form a compound because of the plural marker on the first noun phrase). What this finding suggests was not one my predictions and the analysis with predictors animacy and the possibility of forming a compound was post hoc. Nevertheless, it seems that when the first noun phrase is inanimate and the second noun phrase is animate, the parser

tries to see it as a compound even though it is impossible for them to form a compound (as in *otobüsler şoförü* ‘buses + driver’). Yet, this is not valid for the cases where the parser encounters an animate noun phrase as the first word and an inanimate noun phrase as the second word of the sentence as the RTs in the third region for this constellation did not differ from the other AI constellation where the two noun phrases can form a compound. This may point out that the animacy of two noun phrases (an ambiguous string as used in the experiment) is taken as an indicator of their forming a compound or not, nevertheless, an inanimate-animate string may be a stronger signal that makes the comprehender think that that string is more likely to be a compound than a subject-object sequence.

### 6.3 Conclusion

In the present study, the role of animacy in sentence comprehension was investigated. More specifically, the research question was whether the fact that animacy can be a predictor of the semantic role (i.e. agent, patient) of a noun phrase in a sentence can be used as a heuristic cue to determine its semantic role sooner in the sentence, in other words, before a theta-assigner (i.e. *a verb*). The role of animacy in signaling the theta-roles that noun phrases are more likely to receive (e.g. animate noun phrases tend to be considered as agents, hence, subjects) and in ambiguity resolution has been discussed and observed in previous literature (i.a. Mak, Vonk, Schriefers, 2002; McDonald, 1987). Although the role of animacy in developing strategies in online sentence comprehension has been studied in Turkish before (Demiral et al., 2008), this study is the first investigation of the role of animacy as a feature in strategies that may make the parser resolve subject-verb dependencies in

Turkish earlier than expected (for example, before processing the verb in an SOV language).

The results of a self-paced reading experiment have provided partial evidence for the use of the animacy of noun phrases biasing the parser towards certain parsing decisions. Specifically, the results of the experiment have suggested that the parser does not most of the time take an animate-inanimate NP sequence as a subject-object sequence. However, the results have suggested that the parser often tries to regard an inanimate-animate NP sequence as a compound even when the two noun phrases cannot form a compound (as in the baseline condition of the experiment). Yet, it seems that the parser does not have a strong preference for one of the readings (a subject-object sequence and a compound) over the other as to a locally ambiguous sequence of two noun phrases when the first one is animate and the second one is inanimate, which is implied by the no difference in the RTs in the third region (the one that follows the ambiguous sequence) of the experimental sentences.

Based on the overall results, I can conclude that animacy may have been used as a feature that is considered potentially indicative of the structures coming up in the sentence during online processing. I should state that, however, the results are not fully compatible with the predictions (see Chapter 5). In a nutshell, I can say that participants who took part in the experiment did not seem to get garden-pathed, suggesting that they did not commit to strong parsing preferences based on animacy. Nonetheless, the results of the present study can still be considered consistent with the Good-Enough processing approach. More specifically, it is shown in this study that, based on animacy, the parser can make probabilistic parsing decisions as to the compound-like state of a locally ambiguous string of two noun

phrases. Nevertheless, the predictions that other syntactic parsing models can be crucial in the exploration of animacy information as used in parsing strategies. For instance, my predictions under the assumption that animacy information is not used (see section 5.2.3) can be revised with reference to the garden-path model (Frazier, 1987). This model would predict that animacy information does not make any difference for the processing and disambiguation of an ambiguous sequence of two noun phrases. Nonetheless, this model would predict the use of some other parsing strategies, namely minimal attachment and late closure (Fodor, 1978; Frazier & Fodor, 1978). Late closure, for instance, would predict that a new word should be attached to the current phrase because it is easier to do so than creating a new node. The implication of this strategy for the structures used in the present study is that a compound reading should be preferred more often if the late closure principle is used as a strategy since the compound reading can be gotten sooner than the subject-object reading. In fact, this prediction holds for some of the findings of the present study. However, we cannot explain the findings solely by the predictions of the garden-path model, yet, animacy information and late closure can be used in combination as a strategy fusion in the structures at issue.

The present study has some limitations and can be improved in certain respects. As this study can be regarded as a paving stone in the way to future studies on the role of heuristics in sentence comprehension, I would like to mention some of the drawbacks and points that can be ameliorated in other studies. In the present study, I used the baseline sentences to cancel the compound reading to measure the effect of animacy. Yet, one could use other types of baseline structures. For example, in future explorations of the effect of animacy used as the core component of a heuristic, one should look at similar sentences that begin with a sequence of two

animate noun phrases and sentences that begin with a sequence of two inanimate noun phrases. The question we would ask by using those sentences is whether, for instance, animate-inanimate sentences differ from animate-animate sentences in terms of parsing behavior of the comprehender. More specifically, we would try to understand if the first NP of an animate-inanimate sequence (e.g. *çocuk kitabı* ‘child + book’) is more likely to be taken as a potential subject than the same NP that is the first one of an animate-animate sequence (e.g. *çocuk doktoru* ‘child + doctor’). The reason to use this type of baseline sentences is to measure the potential effect of the animacy of an NP in relation to the animacy of the other NP instead of measuring the effect of the animacy of individual NPs. Another set of sentences I could have used as baseline are sentences where the second NP of the sequence is marked with either *-yI* or *-sI*, in other words, the sequence unambiguously denotes a subject-object string or compound, respectively. However, this baseline strategy is very limited in that the second NP must end in a vowel. If we use such baseline sentences, we would compare between the cases where the second NP is unambiguously marked with the accusative case marker (as in *çocuk bakıcı-yı* ‘child+babysitter’) and the cases where the second NP is unambiguously marked with the compound marker (as in *çocuk bakıcısı*). Reading times observed in such sentences could help us understand how the comprehender treats the ambiguous version (e.g. *çocuk bakıcıları*). More specifically, we would be able to measure how close the ambiguous version is to the unambiguous versions.

A potential problem with the structures I used in the present study originates from the fact that sentences that begin with an ambiguous sequence of two NPs and end in a verb that is transitive can be globally ambiguous since Turkish is a pro-drop language as I briefly mentioned before. As a result, an utterance like

“*Çocuk kitabı okuyacaktı.*” can be interpreted in two ways: “The child was going to read the book.” and “He/she was going to read a children’s book.”. Therefore, I should have either controlled for the effect of pro-drop reading or used structures where this reading is canceled.

Moreover, to draw a comprehensive understanding of the results, one should test the effect of other factors that can modulate the role of animacy. Firstly, assuming that the parser builds up structures probabilistically, the frequency of two consecutive noun phrases being used as a compound or occurring together in the language can certainly affect the parser’s interpretation of those noun phrases in an ambiguous constellation. Unfortunately, there are no Turkish corpora that accurately provide information on the collocation frequency of words. Morpho-semantic features of the compound reading of two noun phrases may also play a role in whether the noun phrases are considered a compound or not before disambiguation. For example, a sequence like *çoban yıldızı* means ‘venus’ with its compound reading, however, it is not a collective of the meanings of the words it consists of (i.e. *çoban* ‘shepherd’ and *yıldız* ‘star’). In other words, when the comprehender sees these two noun phrases together it may be more likely for them to take the sequence as a compound as opposed to a subject-object sequence. Therefore, semantic opaqueness of the compound interpretation of the ambiguous string has most probably an effect on the parsing decision as to this string.

The last point I will make here is not directly about ambiguous sequences of noun phrases but rather about the verbs: Although I controlled the valency of the main verb in the experimental items, those verbs inevitably had different syntactic features with regard to their argument structure. For example, the single-argument verbs can be grouped as inherently intransitive verbs and passive

forms. Even though they can assign a single theta-role, they might behave differently in terms of their semantics. There can be a preference for verbs in active voice over verbs in passive voice as Dinçtopal-Deniz (2014) ), and Dinçtopal-Deniz and Fodor (2017) suggest. What is more, the processing of the disambiguation site (i.e. the main verb) is affected not only by the properties of the ambiguous sequence and the internal structures of the verb but also by the words in between (i.e. the words in the intervener region). Perhaps, those words can possibly bias the comprehender to choose one of the potential readings of the ambiguous sequence. Hence, I could have run another pre-study akin to the plausibility study to control for the effect of the intervener region's meaning. Nevertheless, since it is very difficult to control the syntactic and semantic properties of each and every word of the region (given that there are seven words), I might not have been able to fully control the intervener region. If all these points are taken into account, one can come up with more profound explanations as to the role of animacy in developing heuristics in sentence comprehension.

## APPENDIX

### STIMULI

#### Experimental Sentences<sup>21</sup>

1. Balıkçı(lar) tekneleri alacakaranlığa rağmen ufuk çizgisinde belirdikleri anda sahilden görülmüş / görmüştü yazıyor kitapta.
2. Aşçı(lar) önlüğü arka taraftaki mutfakta duran bir sandalyenin üzerine atılmış / atmıştı yazıyor kitapta.
3. Kasap(lar) bıçakları artık çok eskidiklerinden yeni siparişler için iyice bilendi / bilemiş yazıyor kitapta.
4. Doktor(lar) raporu basit şikayetlerle gelen hastalara öyle kolay kolay verilmez / vermezdi yazıyor kitapta.
5. Konuk(lar) evi bir aylığına tutulacağı için epey uygun fiyata kiralandı / kiralamış yazıyor kitapta.
6. Hasta(lar) yemeği bir hastane yemeğine göre lezzetli olmasına rağmen beğenilmemiş / beğenmemişti yazıyor kitapta.
7. Avukat(lar) cüppeleri büroya yeni alınan palto askısına alelade biçimde asılmış / asmıştı yazıyor kitapta.
8. At(lar) arabaları adanın trafiğe kapatılmış tüm sokaklarında birer birer çekilecek / çekiyordu yazıyor kitapta.
9. Terzi(ler) atölyeleri çok fazla iş olmadığı sırada emektar işçilere temizletilmiş / temizletmişti yazıyor kitapta.
10. Misafir(ler) odaları dairenin mutfağının aksine oldukça temiz bir halde bırakılmış / bırakmıştı yazıyor kitapta.

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<sup>21</sup> All three versions of the sentences are written as a single item. The plural marker *-lar* on the first noun phrase (shown in parentheses) indicates the baseline versions. The single-argument and two-argument versions of the main verbs are separated by a slash “/”. The one to the left of the slash is the single-argument version whereas the one to the right of the slash is the two-argument version.

11. Korsan(lar) gemileri denizde saatlerce süren şiddetli fırtınadan sonra karaya yanaşıyordu / yanaştıracak yazıyor kitapta.
12. Esnaf(lar) loncaları esnaflar odası başkanlığı için yapılacak seçimlerden önce gezilmiş / gezmişti yazıyor kitapta.
13. Kadın(lar) ayakkabıları yatak odasına getirilmiş ahşap gardırobun alttaki rafına konmuştu / koymuştu yazıyor kitapta.
14. Çoban(lar) yıldızı havadaki bulutların gece saatlerinde yok olmasıyla rahatça görülmüş / görmüştü yazıyor kitapta.
15. Sihirbaz(lar) değneği iksirlerin bulunduğu ahşap dolabın içindeyken birden yok olmuştu / etmişti yazıyor kitapta.
16. Yolcu(lar) vagonu istasyonda çalan yangın alarmı sebebiyle aniden boşaltılmış / boşaltmıştı yazıyor kitapta.
17. Asker(ler) postalları kurumaları için güneş alan genişçe bir zemine dizilmiş / dizmişti yazıyor kitapta.
18. Damat(lar) traşı mahalle berberlerine göre pahalı olsa bile ucuza yapılmış / yaptırdı yazıyor kitapta.
19. Peri(ler) masalı merak uyandıran abartılı bir anlatımla çadırdaki cücelere anlatılmış / anlatmıştı yazıyor kitapta.
20. Yaya(lar) geçidi onur yürüyüşünde oluşan kalabalık yüzünden yavaş yavaş geçilmiş / geçmişti yazıyor kitapta.
21. Polis(ler) araçları rota üzerinde gerçekleşen zincirleme kaza yüzünden yoldan çıkmıştı / çıkarmış yazıyor kitapta.
22. Milletvekil(ler)i seçimleri ulusal kanalın saatlerce devam eden programında ele alınmış / almıştı yazıyor kitapta.

23. Çocuk(lar) parkları hava sıcaklığı daha fazla yükselmeden önce rahatça dolaşmış / dolaşmış yazıyor kitapta.
24. Öğrenci(ler) girişi okul dışından öğrencilerin kavgaya geleceği korkusu ile kapatılmış / kapatmıştı yazıyor kitapta.
25. Mahkum(lar) üniformaları öğleden sonra gerçekleşecek içtimadan önce hızlı hızlı toplandı / toplattı yazıyor kitapta.
26. İhtiyar(lar) heyeti söyledikleri son derece uygunsuz sözler yüzünden epey ayıplandı / ayıplamış yazıyor kitapta.
27. Kuaför(ler) salonu şımarık zengin sosyete kadınları gittikten sonra hemen temizlendi / temizlemiş yazıyor kitapta.
28. Cadı(lar) kazanı taş kulübenin içinde depolanan eşyaların dağınıklığı yüzünden devrildi / devirmiş yazıyor kitapta.
29. Nöbetçi(ler) kuleleri tüm yorgunluğa rağmen asla uyumadan sabaha kadar gözetleniyordu / gözetleyecekti yazıyor kitapta.
30. Kovboy(lar) şapkaları üzerlerine konan rengarenk tüyler yüzünden oldukça çok seviliyor / seviyordu yazıyor kitapta.
31. Kayıkçı(lar) küreği yakındaki fırtına yüzünden artan akıntıda denizin sularına düşmüştü / düşürmüştü yazıyor kitapta.
32. Ziyaretçi(ler) defteri yüzyıllık kilisenin içinde birdenbire çıkan karmaşanın ortasında kaybolmuş / kaybetmiş yazıyor kitapta.
33. Halı(lar) dokumacıları atölyede işledikleri karmaşık çiçek motifinin zorluğu yüzünden usanmıştı / usandırdı yazıyor kitapta.
34. Şarap(lar) gurmeleri bağdaki siyah üzümünün verdiği eşsiz aromaya hayran oluyordu / bırakmıştı yazıyor kitapta.

35. Dans(lar) hocaları başka dans türlerinde epey tecrübeli olmalarına rağmen zorlandı / zorlamış yazıyor kitapta.
36. Sigara(lar) tiryakileri başka hastalıklarla savaşıyorlarsa daha bile hızlı şekilde ölüyormuş / öldürüyor yazıyor kitapta.
37. Hazine(ler) avcıları bu macerada önceden yaşadıkları maceralarından daha çok zengileşmişti / zenginleştirdi yazıyor kitapta.
38. Gemici(ler) düğümü çok zorlu görünmesine rağmen oldukça kolay biçimde çözülmüş / çözmüştü yazıyor kitapta.
39. Fındık(lar) fareleri fındık bahçesinde kullanılan zirai ilaç kalıntısı yüzünden zehirlendi / zehirlemiş yazıyor kitapta.
40. Mezar(lar) hırsız gecenin karanlığına alışkın olmasına rağmen orada huzursuz olmuştu / etmişti yazıyor kitapta.
41. Vitrin(ler) mankenleri mağaza sahibinin kullandığı ışıklar yüzünden canlı gibi görünüyormuş / gösteriyordu yazıyor kitapta.
42. Uyuşturucu(lar) kaçakçıları şehir dışındaki eski fabrikada yakalanmadan önce şoka girmişti / sokmuştu yazıyor kitapta.
43. Mahalle(ler) muhtarları geçen çarşamba günü yapılan muhtarlık seçimlerinde yeniden seçilmiş / seçmişti yazıyor kitapta.
44. Hikaye(ler) kahramanı geleneksel ekollere yakın olsa bile modern çizgide betimlenmiş / betimliyordu yazıyor kitapta.
45. Şeker(ler) hastaları genelde pek keyifli geçmeyen seansların sonrasında bile keyifleniyorlar / keyiflendiriyor yazıyor kitapta.
46. Fotoğraf(lar) sanatçıları görsel tekniğin hayatı samimi şekilde aktarması yüzünden şaşırmışlar / şaşırmıştı yazıyor kitapta.

47. Film(ler) yönetmeni hikayede anlatılanın orijinalliđi sebebiyle tüm dünyada meşhur olmuştu / etmişti yazıyor kitapta.
48. Uçak(lar) pilotları kanatlardaki ana motorların duracak gibi olması yüzünden endişeleniyordu / endişelenmişti yazıyor kitapta.
49. Keman(lar) virtüözü marangozun kullandığı kaliteli ceviz ağacının güzelliđi ile büyüldü / büyülemiş yazıyor kitapta.
50. Otobüs(ler) yolcuları merkezdeki otogara varmadan dört yüz metre önce indiler / indirdi yazıyor kitapta.
51. Köy(ler) ağaları modern hayatın getirdiđi sosyal farkındalık yüzünden artık istenmiyordu / istemiyormuş yazıyor kitapta.
52. Akvaryum(lar) balıkları önceden küçük bir ortamda yaşamadıkları için depresyona girmiş / sokmuş yazıyor kitapta.
53. Müzik(ler) yapımcıları saatlerce gürültülü bir yerde toplantı yaptıklarından çılına dönmüştü / çevirdi yazıyor kitapta.
54. Kabin(ler) memuru yol boyunca sarsıntıların kesilmemesi yüzünden sürekli rahatsız olmuştu / etmişti yazıyor kitapta.
55. Mağara(lar) adamı içeride yalnız başına geçirdiđi uzun süre boyunca korkmuştur / korkutmuş yazıyor kitapta.
56. Orman(lar) bekçileri dađdaki köyde dolaşan saçma efsaneler yüzünden geceleri ürküyorlardı / ürkütüyormuş yazıyor kitapta.
57. Grafik(ler) tasarımcıları firma tarafından verilen işin karmaşık detayları yüzünden deliriyormuş / delirtiyordu yazıyor kitapta.
58. Araba(lar) tamircileri sorunun çözülmesinin zorluđu yüzünden epey bir zaman uğraşmıştı / uğraştırdı yazıyor kitapta.

59. Dizi(ler) karakterleri tarihi gerçekliğin dışında oluşturulmuş yeni bir gerçeklikte gösteriliyordu / gösteriliyormuş yazıyor kitapta.
60. Bilgisayar(lar) mühendisi teknoloji ürünlerinin tanıtıldığı geniş çaplı fuarda çok etkilendi / etkilemiş yazıyor kitapta.
61. Evlilik(ler) danışmanı tüm emeklerine rağmen hiçbir şey değiştiremediği için bıkmıştır / bıktırdı yazıyor kitapta.
62. Taksi(ler) şoförü uzun caddedeki bankanın ilerisinde bulunan kafenin önünde ezilmiş / ezmişti yazıyor kitapta.
63. İnşaat(lar) işçileri uzun zamandır cimri işverenleri paralarını vermediğinden bezmişti / bezdirdi yazıyor kitapta.
64. Ameliyat(lar) işçileri yaşlı hastanın durumunun normale dönmemesi yüzünden epey yorulmuş / yormuştu yazıyor kitapta.

#### Fillers

1. Anne kız gelecek ay katılacakları düğün için Nişantaşı'nda alışverişe çıkacakmış yazıyor kitapta.
2. Gelin kaynana toplumdaki genel kanının aksine şaşılacak kadar iyi anlaşıyor yazıyor kitapta.
3. Berber çırağı berberde kullandıkları küçük mavi el havlularıyla dışarı çıktı yazıyor kitapta.
4. Terzi yamağı birkaç top saten kumaş almak için Eminönü'ne gitti yazıyor kitapta.
5. Anneler bebekleri emzirdikten sonra hep birlikte aşağıdaki kafede çay içecekler yazıyor kitapta.
6. Şarkıcı menajeri aradıktan sonra müzisyenlerden biriyle stüdyonun otoparkındaki jipine bindi yazıyor kitapta.

7. Modacı mankeni azarladıktan sonra kıyafet odasına doğru hızlı hızlı ilerledi yazıyor kitapta.
8. Ayı yavruları anneleri yemek için mağaradan çıktığından tek başlarına korkmuşlardı yazıyor kitapta.
9. Rektör yardımcılarını basın açıklaması için rektörlük binasındaki büyük toplantı salonuna gideceklerdi yazıyor kitapta.
10. Aslan terbiyecileri sirkte çıkan yangında diğer çalışanlardan daha fazla yaralanmış yazıyor kitapta.
11. Hayalet avcılarını bilimsel olduğunu öne sürdükleri saçma metotlarla ava çıkmıştı yazıyor kitapta.
12. Kedi balıkları yeni taşındıkları devasa akvaryumun içinde daha rahat yüzüyorlar yazıyor kitapta.
13. Sığır sineği ılıman iklime sahip yeşil alanlardaki sulak arazilerde üreyebilir yazıyor kitapta.
14. Komşu teyze apartman merdivenlerini temizleyen temizlikçi hanıma durduk yere bağırdı yazıyor kitapta.
15. Hasta bakıcı hastanın akşam yemeğini getirmek için birazdan odadan çıkacak yazıyor kitapta.
16. Mafya babaları polisin malikeneye geldiğini öğrenince hemen aşağıdaki depoya saklandılar yazıyor kitapta.
17. Öğretmen çocuğu ondan hiç beklenmeyecek şekilde dün öğlen okuldan kaçmış yazıyor kitapta.
18. Aile bakanı taziye ziyareti için dün gittiği ilçede büyük coşkuyla karşılandı yazıyor kitapta.

19. Cadılar büyücülerini basit birkaç iksirle alt edemeyeceklerini en sonunda anlamışlar yazıyor kitapta.
20. Çocuk adamı bütün gün parkın etrafında sürekli koşarak sinir etmiş yazıyor kitapta.
21. Falcı müşterileri on senedir hiç düşünmeden kandırarak paraya para demiyor yazıyor kitapta.
22. Doktor adayı yakındaki sınav yüzünden sürekli çalıştığı için bitap düşmüştü yazıyor kitapta.
23. Deve kuşu ormandaki hayvan çiftliğindeki birçok attan daha hızlı koşabiliyor yazıyor kitapta.
24. Kral veziri verdiği önemli bilgiler sebebiyle bir sandık altınla mükafatlandırmıştı yazıyor kitapta.
25. Muhabir kameramanı yağmur ihtimaline karşı birer yağmurluk almaya ikna etti yazıyor kitapta.
26. Köpek kedileri caddenin sonundaki yeni yapılan parka kadar dakikalarca kovaladı yazıyor kitapta.
27. Eczacı kalfaları yeni gelen ilaçları raflara dizesinler diye erken çağırması yazıyor kitapta.
28. Hocalar müdürü fark ettikleri yolsuzluklar sebebiyle hep birlikte şikayet edecek yazıyor kitapta.
29. Şoför muavini kendisine bir çay vermesi için ön tarafa çağırdı yazıyor kitapta.
30. Veteriner tavşanı iğnesini yaptıktan hemen sonra kutunun içine geri koydu yazıyor kitapta.
31. Kral soytarıları yaptıkları şovları hiç komik bulmayınca acımasız biçimde cezalandırmış yazıyor kitapta.

32. Kaptan pilot hosteslere motorlardan birinin bozulduğuna dair bir anons yaptırdı yazıyor kitapta.
33. Yüzük parmağı o kadar sıkılmış ki keserek çıkarılmak zorunda kalmış yazıyor kitapta.
34. Uzay istasyonu Jüpiter'de aylar süren araştırmanın ardından kaderine terk edildi yazıyor kitapta.
35. Sigara böreği kısık ateş üzerinde kızgın yağda kızartılınca çıtır olur yazıyor kitapta.
36. Kale duvarları düşman işgali yüzünden hiç olmadığı kadar zarar görmüştü yazıyor kitapta.
37. Kahve makineleri ufak tefek arızaları olduğu için uzun zamandır kullanılmıyormuş yazıyor kitapta.
38. Meyveler sebzeler buzdolabının en alt tarafındaki bölmede epey taze kalmışlar yazıyor kitapta.
39. Futbolcular antrenörü hazırladıkları büyük doğum günü partisiyle epey bir şaşırtmış yazıyor kitapta.
40. Yel değirmeni şiddetlenen rüzgarın etkisiyle normalden iki kat hızlı dönüyordu yazıyor kitapta.
41. Buz pateni yarışmadan sonra içine koyulduğu çantadan biri tarafından alınmış yazıyor kitapta.
42. Davullar zurnalar köy meydanındaki gösterişli düğün sırasında hiç durmaksızın çalındı yazıyor kitapta.
43. Çay bardağı camın kalitesiz olması yüzünden birdenbire çat diye çatlamış yazıyor kitapta.

44. Pirinç pilavı içine konan katı yağ yüzünden oldukça ağır kokuyordu yazıyor kitapta.
45. Duvar boyaları sürekli yağın yağmurların etkisiyle artık iyiden iyiye dökülmüştü yazıyor kitapta.
46. Yastık kılıfları renkleri epey sarardığı için otel görevlileri tarafından değiştirilmiş yazıyor kitapta.
47. Perde kumaşı beklenenin aksine ana salondaki tüm mobilyalara epey uyumuştur yazıyor kitapta.
48. Masa örtüleri haftaya verilecek kalabalık davet için kuru temizlemeciye yıkatılacak yazıyor kitapta.
49. Pantolon askıları çocuğun yaramazlıklarına artık daha fazla dayanamayıp birden kopmuş yazıyor kitapta.
50. Parfüm şişeleri deprem sırasında dükkandaki yüksek kapaksız raflardan düşerek kırılmış yazıyor kitapta.
51. Sokak kapıları eski renklerinin aksine göz alan parlak renklere boyanacak yazıyor kitapta.
52. Ketçap mayonez kızartmaların yanında en çok tüketilen sosların başında gelir yazıyor kitapta.
53. Vücut losyonu geçen gün banyoda kapağı açık bırakıldığı için kurumuş yazıyor kitapta.
54. Fırın tepsileri uzun süre çıkarılmadıkları için yüksek sıcaklık yüzünden mahvetmiş yazıyor kitapta.
55. Domates çorbaları yemekteki önemli konukların hiç hoşuna gitmeyecek kadar ekşitmiş yazıyor kitapta.

56. Saksı çiçeđi çok iyi bakmalarına rađmen küçüklüğü yüzünden çabucak soldurdu yazıyor kitapta.
57. Kestane şekeri diyabetik şekerle hazırlanmadığı için yaşlı adamın şekerini çıkarmış yazıyor kitapta.
58. Telefon görüşmeleri eskiye kıyasla çok daha kolay bir hale getirmişti yazıyor kitapta.
59. Kömür sobaları ne kadar sık temizlense bile is içinde bırakıyordu yazıyor kitapta.
60. Güneş kremi dermatologlar tarafından onaylanmış olsa da çocuđa alerji yapmış yazıyor kitapta.

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