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**The Competition of Memory and
Expectation in Resolving Long-Distance
Dependencies:**

**Psycholinguistic Evidence from
Persian Complex Predicates**

Molood Sadat Safavi



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MACQUARIE
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The Competition of Memory and Expectation in Resolving Long- Distance Dependencies

Psycholinguistic Evidence from Persian Complex Predicates

PhD thesis

to obtain the joint degree of PhD at the
University of Groningen, the University of Potsdam, the University of Trento, Newcastle
University and Macquarie University

on the authority of
the Rector Magnificus of the University of Groningen, Prof. E. Sterken, the President of
the University of Potsdam, Prof. O. Günther, the Rector of the University of Trento,
Prof. P. Collini, the Pro-Vice-Chancellor of the University of Newcastle upon Tyne, Prof.
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Chapter one

Introduction

1. General introduction

The current dissertation aims at investigating the mechanisms involved in resolving long distance dependencies. In this chapter¹, we are going to describe the background of this work from different perspectives. First, we will explain the nature of linguistic dependencies and its different categories. Proceeding to long-distance dependencies, we will investigate the cognitive aspects out of which the two competing memory-based and expectation-based accounts have emerged. Subsequently, we will briefly discuss how these accounts can explain the processing of dependencies across languages.

¹ The content of this dissertation is adopted from the following published work: *Safavi MS, Husain S and Vasisht S (2016) Dependency Resolution Difficulty Increases with Distance in Persian Separable Complex Predicates: Evidence for Expectation-based and Memory-Based Accounts. Front. Psychol. 7:403. doi: 10.3389/fpsyg.2016.00403*

We turn next to complex predicates that were used as the main linguistic structure in the series of experiments we have conducted. Then, we will differentiate the concept of light verbs versus heavy verbs which are the core structures leading to complex versus simple predicate types. Subsequently, we will proceed to Persian as a language in which complex predicates as multi-word verbal constructions are more frequently used as compared to single-word verbs. There are various types of complex predicates in Persian that will be elaborated in details.

In the final section of this chapter, we will give a general overview of the current dissertation including the study population, the methodologies used for the purpose of our research, the approaches we took for the statistical analysis, and the outline of the current dissertation.

1.1. Linguistic dependencies

Dependency Grammar is referred to as a class of Linguistic theories on syntax which are based on dependency relations (Tesnière, 1959). All the elements of an utterance have some internal links and relations, and the speaker uses several grammatical rules to put them together in a well-specified way. As an example for dependency, we can refer to the sentence ‘I love you’ in which the position and the form of both pronouns ‘I’ and ‘you’ depend on the verb whereas the form of the verb depends on ‘I’. However, we cannot conclude that all of these relations can be called dependencies (Mel’čuk, 2009). For example, in the following sentence, *Maria* and *Ms. Müller* (referring to the same person) cannot form a dependency. There must be a one-to-one correspondence between the elements of the dependency meaning that for each element, there is precisely one corresponding node in the structure.

When Maria called her teacher, Ms. Müller was still at school.

Linguistic Dependency is defined as the linguistic relations which are non-symmetrical and in which one of the elements is a prerequisite of the other one, but generally not the other way round. So in the following structure, word 2 (w2) is the dependent on word 1 (w1) which is called the governor (or head, regent, ruler) of w2 (Mel'čuk, 2009).

W1 → W2

Since the earliest grammars like Panini (see Percival, 1997), the concept of *dependency* exists, referring to the constituents of the speech. However, the first person who used the term *dependency* in the grammatical sense was Ibn Mada, the Andalusian linguist in 12th century (Percival, 1976; 1990). Modern dependency grammar (DG) was initiated by the work of Lucien Tesnière (1959), and his syntactic approach was further developed by others (Hays, 1960; Gaifman, 1965; Robinson, 1970). Also, computational linguistics and machine learning have contributed considerably to dependency grammar (Hays, 1972), and there is a growing interest in dependency-based systems for generating dependency treebanks and parsing natural languages (see the proceedings of Depling International Conference on Dependency Linguistics, 2011; 2013; 2015²).

There are different types of *dependency* in language, which are sometimes difficult to disentangle: *semantic dependency*, *morphological dependency*, *prosodic dependency*, and *syntactic dependency*. The focus of the current dissertation is on the last type, namely *syntactic dependency* in a sentence, which will be discussed in the following section. We have to know precisely which particular type of syntactic dependency links w1 and w2. Locality is the most controversial type of syntactic dependency which is the core of the current dissertation and will be explained in section 1.3.1.

² <http://www.depling.org/>

1.1.1. Syntactic dependencies

Syntactic dependencies, as the building blocks of syntactic structure, have been the focus of most linguistic research in dependency grammar. Unlike semantic dependencies (which refer to meaning) and morphological dependencies (which refer to inflectional forms), syntactic dependencies are the abstract dependencies that are not directly related to meaning or form. To put it formally, w_2 is considered to be the dependent of w_1 if the following criteria are met (Mel'čuk, 2009):

Criterion A: connectedness

The fundamental information we need in the first place is to know whether or not w_1 and w_2 are directly linked in syntax. In order to satisfy this criterion,

- (1) the linear position of one of the constituents (in the sentence) must be determined with respect to the other element;
- (2) either w_1 and w_2 form a special syntactic unit (e.g., N+V, N+ADJ, etc.), or w_1 and w_2 , together with another word, form a syntactic unit such that w_1 is the head of the whole phrase and w_2 is the head of the w_2+w phrase (e.g., consider the unit *graduate from the university* where *graduate* (w_1) is the head of the whole unit and *from* (w_2) is the syntactic head of *the university* (w). Therefore, *graduate* and *from* have a direct syntactic link).

Criterion B: dominance

Either w_1 or w_2 must dominate the other one. In other words, one of them needs to be the syntactic governor of the other. In order to ensure this, the following three conditions should be met:

(1) w_1 is the governor of w_2 , then the passive syntactic valency (or the distribution) of the whole phrase must be determined mostly by the passive syntactic valency of w_1 compared to w_2 (e.g., in the phrase *Sir Johns*, the name *Johns* determines the distribution as we can say *I see sir Johns/ I see Johns*, but we cannot say *I see sir*);

(2) there are morphological links between the phrase elements and the external context, such that w_1 controls the inflection of the words outside the phrase or vice versa (the external elements in the context take control of the inflections attached to w_1 (e.g., in the German phrase *drei Gläser Kaffee*: lit. ‘three glasses of coffee’, *Gläser* is the governor, and when it is in the context of a sentence like *Dies-e drei Gläser Kaffee sind super*: lit. ‘these three glasses of coffee are wonderful’, the plurality of *Gläser* as well as the number ‘*drei*’ imposes plural marking to the demonstrative and the verb);

(3) the meaning of the whole phrase is interpreted as a kind/instance of w_2 as the governor (e.g., *a chicken sandwich* is a kind of *sandwich* (w_1), not a kind of *chicken* (w_2)).

In the following sections, we will focus on long-distance dependencies and the relevant theories for resolving such dependencies across languages. In particular, we will discuss locality as the most controversial property of syntactic dependencies. The type of dependency which we use in the current dissertation is the complex predicate that will be explained in details.

1.2. Long distance dependencies

Long-distance dependencies (also called Unbounded, non-local, filler-gap dependencies) have been studied since Fodor’s (1978) research on the

strategies for parsing. However, there are many unanswered questions with regard to this topic (Clifton and Frazier, 1989; Huang and Tang, 1991; Kluender and KITAS, 1993; Traxler and Pickering, 1996; Philips et al., 2005; Fedorenko et al., 2013; among others). We can refer to wh-questions (*who did you talk to?*) or relative clauses (*the girl whom John talked to...*) as examples of long-distance dependencies.

Processing a long-distance dependency between the noun and the verb of a complex predicate or a simple predicate occurs when a listener or reader expects a subcategorizing verb to come after the noun, but he does not know exactly when. Every constituent assigned to a specific grammatical function eliminates most of our expectation to see one other constituent with the same grammatical function as the upcoming element. Consequently, every constituent which we read increases the probability of expectation to see a constituent of a remaining grammatical function in the rest of the clause. So the expectation for finding the subcategorizing verb will increase and, as a result, its processing will be facilitated as well. To put it in other words, the probability of reading a subcategorizing verb (as the next word) rises along with the increase of the number of words that intervene the noun and the verb as the head (Nícenboim et al., 2014).

1.3. Theories on processing long distance dependencies

In this section, two seemingly opposing perspectives of memory-based and expectation-based accounts will be presented to explain the processing difficulty or facilitation that will arise while resolving a long-distance dependency. In order to explain these two accounts, we first give an explanation of long-distance dependency resolution.

1.3.1. Memory-based accounts

It has been thought for a long time that if we increase the distance in a linguistic dependency, such as the distance between a subject and a finite verb, there will be more processing difficulty (Chomsky, 1965; Just and Carpenter, 1992; Gibson, 2000; Lewis and Vasishth, 2005). This phenomenon, a slowdown at the dependency resolution region in case of increased distance between the dependent noun and the head/verb, is commonly referred to as the ‘locality’ effect (e.g., Gibson, 2000; Grodner and Gibson, 2005; Demberg and Keller, 2008; Bartek et al., 2011; Vasishth and Drenhaus, 2011).

It is widely believed that the distance over which a linguistic dependency is resolved is the main parameter for the precision and speed of the dependency resolution (Gibson, 2000, McElree et al., 2003; Lewis and Vasishth, 2005; Levy, 2008; among others). However, it is still a controversial point what underlying cognitive mechanisms are involved when increase in distance affects the accuracy and speed of resolving that dependency (Nicenboim et al., 2014).

According to the Dependency Locality Theory (Gibson, 1998;2000), the slowdown or processing difficulty depends on integration cost and storage cost. Structural integration cost is defined as the processing cost for integrating all intervening constituents while keeping the first part of the dependency in working memory. In fact, structural integration cost is caused by the increasing number of new discourse referents that intervene the constituents of the dependency. Storage cost is the processing cost that is needed to keep the first part of the dependency relation in working memory. The concept of storage cost implies that processing difficulties increase as a function of the number of predicted potential heads (Jäger et al., 2015).

As the Dependency Locality Theory (Gibson, 1998; 2000) suggests, the longer the distance between the head and the dependent constituent, the more difficult it is to retrieve the head from working memory. In a number of studies, the role of working-memory constraints in sentence processing has been established (e.g. Turner and Engle, 1989; Waters and Caplan, 1996; Daneman and Merikle, 1996; Lewis, 1998; Gibson and Thomas, 1999; Gordon et al, 2002; Lewis and Vasishth, 2005; Lewis et al., 2006; Van Dyke and McElree, 2000, 2006; Fedorenko et al., 2006; Otten and Van Berkum, 2009; McVay and Kane, 2011; Van Rij et al., 2013; among others). Hence, limitations that are imposed by the working memory system can be one possible explanation for locality effects. From the perspective of Dependency Locality Theory (Gibson, 1998), the experienced difficulty while processing and resolving a long-distance dependency is related to the decay of the noun in memory.

1.3.2. Expectation-based accounts

Despite strong evidence for locality effects, a growing body of literature shows an opposite effect which is called “anti-locality”. There have been several studies on languages with SOV word order, for example, German (Konieczny, 2000; Konieczny and Döring, 2003; Levy and Keller, 2013) and Hindi (Vasishth, 2003; Vasishth and Lewis, 2006), that provide evidence for a speed-up in dependency resolution when the distance is increased. In many of these studies, the intervening elements can be helpful for strengthening the prediction of the upcoming verb by activating it through modifying the head before the verb actually appears leading to speedup in retrieving the verb (Vasishth and Lewis, 2006). This suggests that processing of the verb/head can be facilitated in case it has already been generated (i.e. the verb has been ‘pre-activated’). This is specifically true for verb-final languages in which the

arguments appear before the verb and modify it (for example, by determining the person or time) before it is actually parsed.

Surprisal (Hale, 2001; Levy, 2008) formalizes the concept of predictive sentence processing or probabilistic parsing and has been widely investigated in event-related brain potential studies (Kutas and Hillyard, 1984; Jurafsky, 1996; Kamide et al., 2003). The so-called *anti-locality* effect can be explained with Surprisal in the framework of the expectation-based account (Levy, 2008) which is based on the assumption that the reader retains and uses language information in a probabilistic way in order to parse that information incrementally.

According to the Surprisal theory, infrequent transitions are difficult to process, that is, the processing difficulty will increase when a parser needs to form a syntactic construction with low probability. In other words, Surprisal is equal to the negative log-probability of seeing a specific word or *word class*, given the preceding context while reading. In the current research, we will follow Levy's (2008) terminology and refer to Surprisal as the expectation-based account.

The assumption in the expectation-based account is that the relative frequency of a construction can affect the time it needs to be processed. To be specific, as defined by Hale (2001) and Levy (2008), Surprisal predicts that the processing difficulty which is associated with the integration cost of a certain word depends on how probable it is for the head to appear (given the previous context). So, the higher the Surprisal values, the more processing difficulty, hence, the longer reading times (Jäger et al., 2015).

1.3.3. Mixed accounts

We cannot conclude on the mutual exclusiveness of the memory-based and expectation-based accounts as the recent investigations (Staub, 2010; Vasishth and Drenhaus, 2011; Levy et al., 2013; among others) indicate the need for insights from both theories.

It is still not very clear how working memory influences expectation-based parsing. There are researchers like Levy (2008) who argue the expectations play a crucial role only when working memory load is low. So, they suggest that prediction of the upcoming words is also dependent on working memory. The reason is that the reader's expectation also depends on the accumulated information. As a result, readers with low working memory capacity, whose ability to manipulate information and store it temporarily is decreased, will parse the sentence slower than the high-working-memory-capacity readers when it comes to expecting the upcoming lexical items.

As in many of the above-mentioned studies, evidence for both accounts have been found. We can conclude that both memory and expectation play a role to some extent. For example, an eye-tracking study by Staub (2010) provides evidence for both even though these effects take place in different regions of the sentence.

Below is an example of Staub's (2010) study which showed processing difficulty on the object noun-phrase in the subject relative clause ('the fireman' in example a) as compared to the subject noun phrase in the object relative clause ('the fireman' in example b). This result is in line with the expectation-based account as the comprehender needs to build an infrequent structure (object relative clause) when he/she reads the noun phrase. It is also consistent with memory-based accounts based on which there is more

processing difficulty at the position of the relative clause verb of the object relative clause than the subject relative clause.

a. The employees that noticed the fireman hurried across the open field.

b. The employees that the fireman noticed hurried across the open field.

Studies by Vasishth and Drenhaus (2011) and Levy and Keller (2013) suggest that there are locality effects when working memory load is high (see also, Van Dyke et al., 2014). The anti-locality effects may appear in case of low working memory load.

In a recent study, Husain and colleagues (2014) argue that the prediction of a precise lexical item (high predictability of a head) can neutralize the effect of locality. Therefore, they suggest that the effect of locality shows up when there is a weak predictability strength, that is, when a verb is predicted regardless of its exact identity. Husain and colleagues (2014) conducted a self-paced reading study with a 2x2 factorial design in which they crossed the factors of dependency distance and predictability in order to study the locality and expectation effects. They used Hindi, an SOV language, to test complex predicates with a light verb and with a ‘heavy’ verb. In the strong predictability condition, the light verb was strongly predictable by the object NP noun phrase and in the low predictability condition, the heavy verb was not predictable by the object noun phrase. In the conditions in which there was a high predictability, the exact verb identity was predicted by the object noun phrase, whereas in the low predictability conditions, the object noun phrase did not predict the exact verb with a high level of certainty- even though it predicted some verbs.

Husain et al., (2014) manipulated another factor, dependency distance, such that in the short conditions, one or two adverbials were placed between the object noun phrase and the verb. When there was one adverbial in the short

condition, the corresponding long condition had two adverbials; when there were two adverbials in the short condition, the corresponding long condition had three adverbials. Reading time was measured at the verb. The results showed that the complex predicate with light verbs were read slower in the short than in long conditions. Below, you can find examples for the sentences Hussain and colleagues (2014) used. In *khayaal rakhnaa* ('care keep/put'; 'to take care of') both the noun *khayaal* and the verb *rakhnaa* form the predicate while in *gitaar rakhnaa*, 'guitar keep/put'; 'to put down or keep a guitar' *gitaar* is an object of *rakhnaa*.

a. Complex predicate, Long

maa ne bachche ko skUla CoRaa Ora use kahaa ki vah/apnaa
 mother ERG child ACC school dropped and to her said that **she her**
khayal binaa kisi laaparvaahi ke achCe serakhe, phir va apne
care without any carelessness properly keep, then she her
daftar ki ora chal paRii
 towards office proceeded

'The mother dropped the child off at the school and asked her to take care of herself properly without any carelessness, she then proceeded towards her office.'

b. Complex predicate, Short

maa ne bachche ko skUla CoRaa Ora use kahaa ki vah apnaa
 mother ERG child ACC school dropped and to her said that **she her**
khayal achCe se rakhe, phir vah apne daftar ki ora chal paRii
care properly keep, then she her towards office proceeded

'The mother dropped the child off at the school and asked her to take care of herself properly, she then proceeded towards her office.'

c. Simple predicate argument-verb, Long

maa ne bachche ko skUla CoRaa Ora use kahaa ki vah apnaa
mother ERG child ACC school dropped and to her said that **she her**
gitaar binaa kisi laaparvaahi ke achCe se rakhe, phir vah apne
guitar without any carelessness properly keep, then she her
daftar ki ora chal paRii
towards office proceeded

‘The mother dropped the child off at the school and asked her to keep her guitar properly without any carelessness, she then proceeded towards her office.’

d. Simple predicate argument-verb, Short

maa ne bachche ko skUla CoRaa Ora use kahaa ki vah/apnaa
mother ERG child ACC school dropped and to her said that **she her**
gitaar achCe se rakhe, phir vah apne daftar ki ora chal paRii
guitar properly keep, then she her towards office proceeded

‘The mother dropped the child off at the school and asked her to keep her guitar properly, she then proceeded towards her office.’

However, there seemed to be a slowdown at the verb of the simple predicate (noun-heavy verb) compared to the complex predicate condition (noun-light verb). There was also weak evidence for an interaction between the distance and predictability which indicated that when the distance increased, there was a slowdown in the simple predicate conditions (noun + light verb) and a speedup in the complex predicate ones (noun + heavy verb). Husain et al. (2014) concluded that the locality effect is canceled when the head is highly predictable. The locality effect was seen only in cases of weak predictability.

1.4. Long-distance dependency resolution across languages

Despite cross-linguistic evidence in favor of memory-based accounts such as the Dependency Locality Theory in languages like English (Gibson, 1998; 2000), Spanish (Cuetos and Mitchell, 1988), Dutch (Bach et al., 1986), Finnish (Hyönä and Pollatsek, 1998), German (Bader et al., 1996; Hemforth et al., 1993), Russian (Levy et al., 2013), and Chinese (Hsiao and Gibson, 2003), in some languages such as Hindi, German, and Russian, it has also been found that increasing the distance between the noun and the verb facilitates processing of the verb (Konieczny, 2000; Vasishth and Lewis, 2006; Jaeger et al., 2008; Vasishth and Drenhaus, 2011; Levy and Keller, 2013; Husain et al., 2014; Jäger et al., 2015).

According to Levy (2008), head-final syntactic dependencies can be a source of divergence between memory-based and expectation-based accounts. There are numerous cases in which the comprehender expects a specific final head, but does not know when it appears. This situation can be found in verb-final languages such as German (e.g., Konieczny, 2000) and Hindi (e.g., Vasishth and Lewis, 2006; Husain et al., 2014). In these cases, the Dependency Locality Theory argues that a larger number of elements appearing before the head (i.e., the verb) will lead to more processing difficulty at the position of the upcoming head because all of these elements are supposed to be integrated simultaneously.

However, the Surprisal theory has a different prediction in this situation. According to this theory, the dependent elements provide us with information about the head. So, the more we know, the faster we can identify the location and the identity of the head and the quicker we can process it.

In this dissertation, we will concentrate our experiments on complex predicates in Persian which is a verb-final language. First, we will present a short introduction on the nature of complex predicates as they appear in light-verb constructions. Then Persian complex predicates will be explained further. The added value of studying Persian is that the frequency of complex predicates is considerably higher in this language (as compared to the simple predicates which are very infrequent). Also, we plan to include more syntactic complexity (e.g., relative clause and prepositional phrase in the manipulation of the intervening elements as compared to the Hindi study where adverbial was the only type of intervener).

1.5. Complex predicates and light verbs

In this section, complex predicates as the linguistic structure we used for our research will be described. The difference between light verbs and heavy verbs will be also clarified in this section. We will then focus on the categories of these constructions in Persian language.

Complex Predicates, also known as compound verbs or Light Verb Constructions, are comprised of a non-verbal element (e.g., noun: *zarbe*, ‘harm’) and a verb (e.g., light verb: *zadan*, ‘to hit’) that lacks sufficient semantic properties to function as an independent predicate. Together they can form a complex predicate: *zarbe zadan*, lit. ‘harm hit’, ‘to harm’ (Vahedi-Langroudi, 1996; Karimi-Doostan, 1997, 2005; Synder, 2001; Baker and Harvey, 2010; Butt, 2010)³.

According to Samvelian (2001), the meaning of the sequence forming the complex predicate is often non-compositional, that is, we cannot usually find out the precise meaning of the complex predicate through the meaning of its

³ Examples are from Persian language.

individual words. For example, in Persian, *zamin*: lit. ‘earth’ together with *khordan*: lit. ‘to eat’ forms the complex predicate *zamin khordan* which means ‘to fall down’, so the meaning cannot be understood through the literal interpretation of its components (‘eat earth’). The verb (which is not completely meaningful by itself) used in the complex predicate is called a ‘light verb’; this will be explained in the following section. As opposed to a light verb, a ‘heavy verb’ (also, ‘rich verb’) is a verb that contains enough semantic properties to function independently (see also, Stevenson et al., 2004; Wittenberg et al, 2014).

The first time that the term *light verb* was used (Jespersen, 1965), it referred to a semantically null verb in English (e.g. *take* in *take a walk* versus *walk*) that gets tense and person agreement and does not have a main semantic contribution to the construction.

The set of *light verbs* is considered to be part of the verbal grammatical category, as Cattell (1984) suggests. He argues that a *light verb* indicates and confirms the occurrence of an action or event expressed by the dependent noun in a complex predicate. According to him, a *light verb* elaborates on the syntactic and semantic limitations of the light verb constructions and their lexical counterparts. Despite his detailed analysis of English complex predicates, he concludes that it is impossible to come up with an algorithm that foresees which particular complement will combine with which *light verb*.

Since this terminology (i.e. *light verb*) was coined by Jespersen (1965), it has been used in the analyses of structures in a variety of languages. In the framework of the Generative Grammar, the term ‘*light verb*’ was used in analyzing the *Suru* structure in Japanese. *Suru* is a verb that means ‘to do’, and it is usually combined with nominals to form a complex predicate. This verb is light in terms of semantic properties and only has a functional role (Grimshaw and Mester, 1988). As another example, we can refer to Hindi

noun + light verb complex predicates (Mohanani, 1994) like ‘varNan kar’ , ‘description + do’, meaning ‘to describe’. In these studies, ‘complex predicate’ refers to a structure that has two or more predicational elements such as verbs, nouns, adjectives, that form one single predicate. Many other researchers have focused on light verbs and complex predicates in a variety of languages (Ahn, 1991, on Korean; Sato 1993, on Japanese; Butt, 1995; 2003, on Urdu; Diesing, 1997; 2000, on Yiddish; Choi and Wechsler, 2001, on Korean; Butt and Ramchand, 2005, on Hindi and Urdu, among others). Here, we focus on Persian.

1.5.1. Persian complex predicates

In Persian, there is a strong preference for using multiword (also, compound) verbs over simple ones (Nemati et al., 2010). According to Sadeghi (1993), the number of simple (one-word) verbs that are used in spoken and written Persian is not higher than 150. He argues that this situation is not a new tendency and that forming multiword verbal expressions already happened long before the flow of borrowings from Arabic and other foreign languages such as French, English, and Russian. As most of the verbs in Persian are complex, Persian complex predicates have been investigated in many studies (Samiiian, 1983; Barjasteh, 1983; DabirMoghadam, 1982, 1997; Goldberg, 1996, 2012; Ghomeshi, 1997; Kahnemuyipour, 2004; Karimi, 1987, 1997; Karimi-doostan, 1997; Khanlari, 1986; Megerdooomian, 2002, 2004, 2005, 2008, 2012; Sadeghi, 1993; Samvelian, 2001; Vahedi-Langrudi, 1996; Toosarvandi, 2006, 2009; Pantcheva, 2008, 2010; Sedighi, 2009; Taleghani, 2010; Taslimpoor et al., 2012; among many others).

There have been many attempts in the literature to model the semantic processing versus syntactic processing of complex predicates. Hale and

Keyser (1993; 2002) suggest that each syntactic role should be mapped onto a semantic argument in a one-to-one way. Alternatively, Goldberg (2003) argues that complex predicates can be treated as independent units which are stored in memory (or lexicon) with their full syntactic and semantic features. A third approach (Jackendoff, 2002; Culicover and Jackendoff, 2005) differentiates between syntactic and semantic levels and takes them as independent structures. Culicover and Jackendoff (2005) suggest that Persian speakers prefer to make complex predicates in the need for a new event type instead of going through a morphological lexeme formation process. Still, they argue that despite being multi-word expressions, forming a complex predicate has to be treated similarly as the lexeme formation process. Therefore, the syntactic features of the complex predicates are the same as those of the simple predicates (a verb with an object noun phrase).

In fact, there is no categorical syntactic difference between the nominal part of the complex predicates and the direct object of the simple predicates although the nominal part of the complex predicate can be more cohesive with its light verb than a direct object in combination with a heavy verb. This cohesion can be found in word order, stress, differential object marking, pronominal affix placement, et cetera (Karimi-Doostan, 1997; Goldberg 2003).

The light verb in Persian can be combined with different types of non-verbal items such as noun, adjective and prepositional phrases (DabirMoghaddam, 1997). DabirMoghaddam (1997) has classified these verbs into different categories as described in the following example:

Types of Persian complex predicates (DabirMoghaddam, 1997)

I. Combination

1. Adjective + Auxiliary verb

1. The stative auxiliary *budan* 'to be'
delxor budan: lit. 'annoyed be': 'to be annoyed'.
2. The inchoative auxiliary *shodan* 'to become'
delxor shodan: lit. 'annoyed become': 'to become annoyed'.
3. The causative auxiliary *kardan* 'to make'
delxor kardan: lit. 'annoyed make': 'to annoy'.

2. Noun + Verb

4. *Kardan* 'to do', e.g., *tahdid kardan*: lit. 'threat do': 'to threaten'
5. *Zadan* 'to strike, to beat', e.g., *seda zadan*: lit. 'sound bit': 'to call'
6. *Dadan* 'to give', e.g., *pas dadan*: lit. 'back give': 'to return'
7. *Gereftan* 'to take', e.g., *tahvil gereftan*: lit. 'delivery take': 'to take delivery of'
8. *Keshidan* 'to draw', e.g., *sut keshidan*: lit. 'whistle draw': 'to whistle'
9. *Dashtan* 'to have', e.g., *dust dashtan*: lit. 'friend have': 'to like'
10. *Khordan* 'to eat', e.g., *sarma khordan*: lit. 'cold eat': 'to catch cold'

3. Prepositional Phrase + Verb

Amadan 'to come', e.g., *be donya amadan*: lit. 'to world come': 'to be born'

4. Adverb + Verb

Andaxtan 'to throw', e.g., *bar-andakhtan*: lit. 'off throw': 'to overthrow'

5. Past participle + Passive auxiliary

Shodan 'to become', e.g., *sakhte shodan*: lit. 'built become': 'to be built'

II. Incorporation

Dadan 'to give', e.g., *ghaza dadan*: lit. 'food give': 'to feed'
or *dashtan*, 'to have', e.g., *entezar dashtan*: lit. 'expectation have': 'to expect'

Karimi-Doostan (2011) divides Persian complex predicates into two groups: separable and inseparable. The nominal preverbal element in the separable complex predicates can be a direct object, relativized, modified by an adjective, et cetera. Karimi-Doostan (2011) argues that separability or inseparability of these constructions can indicate their formation at two levels. In chapter 2, we will elaborate more on the issue of separability and the way it depends on the semantic and morpho-syntactic features of the preverbal element, as well as on the light verb (see also, Dehdari, 2005).

Linguists take different stances towards the nature of Persian Complex predicates. On the one hand, the non-compositionality of the semantics in these constructions has led some researchers to believe that complex predicates are formed in the lexicon (Ghameshi and Massam, 1994; Goldberg, 1996; Karimi-doostan, 1997). On the other hand, the separability of some complex predicates have made other linguists propose the theory that complex predicates are syntactic units formed during syntactic processing (Heny and Samiian, 1992; Vahedi-Langrudi, 1996; Megerdooonian, 2001, 2002; Folli et al., 2005; among others). Goldberg (2003) proposes a mixed analysis that treats Persian Complex predicates as words by default and as phrases in exceptional situations.

According to Bonami and Samvelian (2010), the syntactic properties of complex predicates are identical to those of combinations of a verb with an object noun phrase. While there is a tendency for the noun in a complex predicate to be more cohesive with the verb than a direct object noun is (in terms of word order, stress, differential object marking, pronominal affix placement), there is no categorical syntactic contrast between the two types of sequences (Karimi-doostan, 1997; Goldberg, 2003).

Samvelian and Faghiri (2013, 2014), as well as Goldberg (1996) and Family (2006), argue that all Persian complex predicates must be listed in the lexicon

as they follow the conventional pairings of form and meaning. They emphasize that the storage of these constructions does not contradict the compositional view if the concept of compositionality is referred to idiomatically combining expressions. Their approach goes against the majority of the previous studies in the literature on Persian complex predicates that have a radically compositional perspective based on the assumption that the contribution of all the components in a complex predicate is consistent in all the combinations. They proposed the Construction-based approach based on the assumption that although Persian complex predicates can be idiomatic, they can still be categorized in different groups according to their semantic and syntactic features. The matter of productivity of Persian complex predicates cannot be investigated thoroughly without resorting to more quantitative methods for the analysis. In this way, Samvelian and Faghiri (2014) provide a Construction-based explanation that allows to account for the productivity of Persian complex predicates in a way that considers their compositionality and idiomacity at the same time.

Müller (2010) argues that a combination of a lexical account and grammatical operation rules and the analysis of argument structure has none of the flaws of the above-mentioned classifications and it can address both the lexical and the syntactic features of Persian complex predicates. He suggests that relying exclusively on the pattern classification is not an insightful way of treating Persian complex predicates. He argues that a combination of a lexical account with a grammatical operation and the analysis of argument structure has none of the flaws of the above-mentioned classifications and it can address both lexical and syntactic features of Persian complex predicates. He emphasizes that his account does not contradict the Construction-based grammar. In fact, his analysis is fully compatible with the central idea of Construction Grammar.

Family (2006) argues that complex predicates retain some elements from the meaning of their light verbs. This meaning is the one that a Persian native speaker considers as the meaning of that verb (when it is heavy) in a simple predicate structure. She believes that in the Persian system of verbs, the semantic space⁴ consists of some islands which are formed when a cluster of complex predicates with a particular light verb refers to very similar meanings. She states that Persian speakers' productive capacity lies in knowing and developing a highly-structured semantic space in which there are many nodes serving as attractors to specific types of verbal meanings.

In sum, one can generalize that Persian Complex predicates contain semantic, lexical, and syntactic information, and a differentiation between grammar and the lexicon is superfluous (Family, 2006). Therefore, complex predicates are interesting constructions that display both syntactic and lexical features, that is, they participate in syntactic processing, whereas they often have a non-compositional meaning (Amtrup and Megerdooian, 2007). Some complex predicates can be separated by interveners, but other cannot.

Complex predicate constructions in Persian cause considerable complications for language technology (e.g., machine translation) as they display both lexical and phrasal features. On the one hand, the meaning of the construction is usually non-compositional. On the other hand, complex predicates can take part in syntactic processes, for example, the constituents can usually be separated by interveners. This situation causes a divergence in translation as the complex predicates should be translated to single word forms in the other language. In general, these constructions pose challenges to the current well-established theories of linguistics (Ershadi, 2011). Particularly, they can be

⁴Semantic space is a framework for representing the meanings of words by encoding them as vectors with different dimensions: a semantic axis, a functional axis, and a thematic axis (see Osgood et al, 1957)

used to study two contradicting accounts of locality and expectation by lengthening the intervener between the two parts of the separable complex predicates.

The nature of complex predicates has been compared to idioms due to their non-compositional meaning. However, it is not necessarily the case that all non-literal structures are idioms (Ershadi, 2011). For example, we can refer to the cases of cliché and metonymy across languages (O’Grady, 1998; Jackendoff, 1985). Idioms have their own internal structure and possess some features that characterize them differently in some aspects from other constructions. One of the distinguishing features is that speakers cannot / do not create new idioms without a specific context even in a language in which productive processes like compounding are very common. In case of Persian, complex predicates are extremely productive, and native speakers create them regularly as there is a general preference for using multi-word verbs in this language (Ershadi, 2011). As another factor, we can refer to the structure of complex predicates compared to simple predicates, that is, the verb argument in a simple predicate is a nonverbal element in itself while both noun and verb of a complex predicate together are part of the verbal structure (Megerdooonian 2006). Idioms, however, have their own structure as a whole.

Based on Prague Dependency Treebank (2003), the borderline between complex predicates and verbal idioms are defined as follows: (1) in complex predicates, the governing verb is null from semantic point of view, and the lexical meaning is determined by the dependent noun. However, the meaning of an idiom is interpreted as a whole, not as a combination of meanings of individual words; (2) the complex predicate may be replaced by a one-word predicate whereas idioms do not have a corresponding one-word predicate; and (3) the dependent noun of a complex predicate keeps its valency and ability to get modified while the dependent noun of an idiom loses its valency,

that is, it cannot be modified freely, and its properties depend on the head of the idiom.

Also, we made sure that our experimental stimuli are not ambiguous as in garden path situation where the readers' most likely and first interpretation of the sentence is incorrect, and they go through a costly re-analysis leading to slow-down in processing. Based on garden path model, the semantic and contextual processing come only after syntactic parsing which causes a re-analysis of the parse (Frazier, 1987; Trueswell et al., 1993; Pickering and Van Compel, 2006). An example for a garden path sentence is 'the old man the boat' that guides the reader toward a meaning which is not the intended one. Such a sentence might seem ungrammatical at the first glance and requires careful rereading to be fully understood. In this particular example, 'man' functions as the verb for 'the old' which means that 'old people work on the boat'. So, in the experimental stimuli, we tried to avoid such ambiguous situations to rule out extra difficulty (other than the distance and predictability manipulation we tested) in parsing the long-distance dependencies.

Furthermore, in order to make sure that our participants do not engage in a good-enough processing approach to come up with a shallow and superficial interpretation of the sentence when they face difficulty in comprehension (Ferreira et al., 2009), we carefully selected the comprehension-check questions targeting different parts of the experimental sentences.

1.6. The current dissertation

In the present dissertation, we build upon on the work by Husain et al. (2014) described earlier. Husain and colleagues' work on Hindi suggests that the strength of the predictability modulates whether locality effects occur or not; we investigate this claim cross-linguistically using Persian language, which,

like Hindi, has a complex predicate construction that allows us to manipulate strong and weak predictability. What motivated us to study the two competing accounts of memory and expectation in was the considerably high number of complex predicates (versus simple predicates) in this language. Also, what makes the current series of studies particularly different from the Hindi experiment is that more syntactic complexity is added in the intervening materials of the Persian experiments as compared to the Hindi experiments where only adverbials separated the parts of the complex predicates. The general aim of this study is to understand the effects of memory and expectation involved in sentence processing.

1.6.1. Study population

For the purpose of the current studies, we tested all in all 279 participants who were all Persian native speakers, having minimally 12 years of school education (up to PhD), with normal or corrected-to-normal eye-sight, and the age range of 20 to 40. The 114 participants took part in the pretests (presented in the next chapter) and conducted them on an internet-based platform.

For the main studies, 85 native speakers of Persian participated in the online-masked self-paced reading experiments in Tehran, Iran in March 2014. The other 80 participants who took part in the Eye-tracking studies lived in Potsdam or Berlin and were tested in the language processing Lab in University of Potsdam.

1.6.2. Methodologies

We used a variety of methodologies to test our hypothesis. Firstly, in order to validate our design, we used a sentence-completion task along with an

acceptability rating pre-test. Then we did two self-paced reading studies followed by two eye-tracking experiments. What initially motivated us to replicate and reproduce our result with another method was the recent replication crisis in psychology (Open Science Collaboration, 2015). Also, it is likely that self-paced reading overburdens the working memory in an unnatural manner as it does not expose the whole sentence to the readers' eye which might affect the reading time data. So, our aim was to find out whether using a more precise and natural online method like eye-tracking changes our results. We specifically looked for the first-pass reading time and regression-path duration based on the proportion of the participants' eye gaze across the whole sentence.

1.6.3. Statistical analysis

The data were analyzed in R programming environment (R Development Core Team, 2013). We analyzed the experiments using the two following approaches.

1.6.3.1. Linear mixed models

The approach we employed for statistical analysis was linear mixed effect modeling (LMM; Pinheiro and Bates, 2000) which falls in the category of regression models and includes both fixed effects (i.e., predictors) and random effects. An implementation of this model ready for use can be found in the package lme4 (Bates et al., 2015). In case of large samples, an approximation of the normal distribution is represented by the t distribution. An absolute t value bigger than 2 shows a significant effect at $\alpha = 0.05$. In order to code the main effects and the interactions, sum contrasts were used in the current project.

As a secondary analysis, a nested contrast was defined in addition to the analysis of the main effects in order to look at the effect of distance in complex predicates versus the control conditions separately; the conditions were also coded as sum contrasts. Based on the `rePCA` function in `RePscychLing` package (Bates et al., 2015), we analyzed the reading time and chose the most complex model possible according to the data and the design. The `rePCA` function performs a Principal Component Analysis (PCA) of the random-effects variance-covariance matrices for the random effects (items and subjects) that allows the modeler to include the appropriate variance components.

In statistical analysis of the empirical data, it is highly important to avoid overfitting (Bates et al., 2015). Any specific data set can bear only a certain amount of complexity in the model and this can be formulated by the number of parameters in the model. Mixed-effects modeling also follows this general principle. Barr et al. (2013) recommends to fit ‘maximal’ models with all possible random effect components included step by step. This idea is supported by a tradition in statistics that aims for a verdict on significance in factorial designs. Barr et al. (2013) establish their recommendation on a simulation study indicating that we can avoid anti-conservative results by fitting models which have a rich random effects structure.

During the last decade, significant changes have occurred in approaches to statistical analysis of psycholinguistic experiments when random factors are included (subjects and items) as well. One of these significant changes is specifically a change from analyses of variance to linear mixed models (see Baayen et al. (2008) for the first major presentation of this concept).

An interesting advantage of the new method is that, with linear mixed models, there is no need for separate analyses of variance for subject and items when we draw statistical inference about experimental effects and interactions in a single cohesive framework (Clark, 1973; Forster and Dickinson, 1976). This advantage in coherence does not come without a cost. An important part of employing mixed-effects models for analyzing the results of the experiments is the way proper random-effects structure is selected. Basically, linear mixed models consider variance in random intercepts and random slopes as well as the correlations between these two (Bates et al., 2015).

1.6.3.2. Bayesian inferences

The second approach we employed for statistical analysis was using Bayesian hierarchical models using Stan (Stan Development Team, 2014; Gabry and Goodrich, 2016). Sum contrasts were used in our study in order to code the main effects and interactions.

As a secondary analysis, a nested contrast was fitted in addition to the analysis of main effects so that we can find the effect of distance in complex predicate conditions versus simple predicate conditions; these nested contrasts were also coded as sum contrasts. For all the participants and items, we employed the so-called maximal models which are full variance-covariance matrices (Barr et al., 2013; Bates et al., 2015).

In order to check if there is an effect of a specific factor, according to Bayesian modeling, we measure whether or not the 95% uncertainty interval includes zero (Safavi et al., 2016). For the review of Bayesian statistical modeling in psycholinguistic research refer to Sorensen and Vasishth (2015); Nicenboim and Vasishth (2016).

1.6.4. Structure of the dissertation

In the next three chapters, our research will be presented in the form of three related studies. In each of these chapters, two experiments are included. Chapter 2 will be allocated to the pre-tests that allowed us to validate our experimental design and proceed to the main studies. In this chapter, we will derive the predictions of the expectation-based account through sentence completion tasks.

Then, we will check for the acceptability of the separable complex predicates which are used as the stimuli. A corpus analysis of the conditional probability of the light verbs in Persian will be presented in the second chapter as well. In chapter 3, we will present the first two online experiments with the self-paced reading methodology. In chapter 4, the two studies conducted with eye-tracking method will be described. Chapter 5 presents a general discussion on the research we have conducted and the implications for the theories that were tested. Possible further directions will be discussed in chapter 5 as well.

Chapter two

To what extent can we predict the identity of a verb in Persian separable complex predicates?

2.1. Introduction

In this chapter, we will present the pre-tests that aimed at validating our experimental materials for the purpose of the study: finding support for memory-based (Gibson, 2000; Lewis and Vasishth, 2005) or expectation-based accounts (Levy, 2008) of long-distance dependency resolution in Persian separable complex predicates. As the first step for this research, we investigated the notion of predictability in complex predicates through two sentence-completion tasks. Then a separability rating study was conducted to make sure that Persian native speakers consider the particular type of complex predicates we used in our design as separable. Next, a corpus study was done

on Persian dependency treebanks so that we have an estimation of to what extent the conditional probabilities of predicting the light verb may change in the noun-light verb constructions as a function of distance. Also, we extracted some information about the frequency of non-adjacent complex predicates from Persian and Hindi treebanks. We ran these pretests to confirm the reliability of the stimuli for the four main experiments (self-paced reading and eye-tracking) which will be discussed in chapter 3 and chapter 4.

2.2. Predictability of the head in a long-distance dependency

The offline sentence-completion tasks were conducted to validate the experimental stimuli and to have an estimation for the predictability of the target light verb versus heavy verb. The previous studies on expectation-based accounts suggest that sentence-completion studies are beneficial for this purpose.

As an example, Levy and Keller (2013) used this method in order to derive their predictions as a complementary study to their corpus study. They used a Cloze sentence-completion test to make sure that the manipulated position of the German dative influences the comprehender's expectation regarding the identity of the verb. For this purpose, they provided the sentence context to the reader up to the critical word which was the verb, and the participants were supposed to complete the sentences. All of the continuations were annotated by a native speaker of German to verify the participants' judgements. So the key concern of their study was whether or not the intervener (dative noun phrase) led to predicting the dative-case verb. The aim of their study was to understand whether manipulating the dative argument positioning can influence the persons' expectations about the identity of the verb. Their results

indicated that the presence of the intervening elements sharpened the readers' expectation for the target verb. Here is an example for their stimuli:

a. *Hans hat den Fußball versteckt.*

Hans has the.ACC football hidden.

'Hans hid the football.'

b. *Hans hat zur Ahndung den Fußball versteckt.*

Hans has as payback the.ACC football hidden.

'Hans hid the football as payback.'

c. *Hans hat dem Sohn den Fußball versteckt.*

Hans has the.DAT son the.ACC football hidden.

'Hans hid the football from the son.'

d. *Hans hat zur Ahndung dem Sohn den Fußball versteckt.*

Hans has as payback the.DAT son the.ACC football hidden.

'Hans hid the football from the son as payback.'

In a similar study by Husain and colleagues (2014), sentence completion tasks were used to confirm that, on the one hand, the identity of the light verb was highly predictable in complex predicate conditions, and that, on the other hand, the precise identity of the heavy verb was unpredictable in simple predicate conditions in Hindi. Below you can find an example for the design of their pretest. The participants were presented the sentence up to the noun which is 'Khayaal', lit. 'care' in case of the complex predicate condition and 'gitaar', lit. 'guitar' which is the potential object of the upcoming heavy verb in the simple predicate condition.

a. *maa ne bachche ko skUla CoRaa Ora use kahaa ki*

mother ERG child ACC school dropped and to her said that

vah apnaa khayaal...

she her care...

b. *maa ne bachche ko skUla CoRaa Ora usse kahaa ki*

mother ERG child ACC school dropped and to her said that

vah apnaa gitaar ...

she her guitar

Therefore, we aim to collect empirical evidence from Persian sentence-completion studies to find out whether or not predicting a particular verb or a type of verb can be sharpened by the intervener, and we can count on a sentence-completion study as an informative method to measure the predictability of the head and to validate the stimuli. However, the nature of the intervener is of crucial importance for determining the extent to which the predictions are sharpened (Konieczny, 2000; Grodner and Gibson, 2005).

In our studies, the main goal of the sentence-completion tasks was to confirm that:

1. the identity of the light verb is strongly predictable in complex predicate conditions
2. the identity of the heavy verb is unpredictable in simple predicate conditions

In this section, the sentence completion studies will be presented. They are considered to be a part of the pre-tests we did to validate the materials used in the later experiments. The aim for conducting such tests was to find the most predictable light verb and the most unpredictable heavy verb in order to manipulate predictability in the long-distance dependency we investigated.

2.2.1. Predictability of the light and heavy verbs I

The first sentence-completion task targets the stimuli which were used in the first masked self-paced reading (presented in chapter 3) and the first eye-tracking study (presented in chapter 4). Further details on why we used this particular design will be given in the corresponding chapters.

2.2.1.1. Methodology

2.2.1.1.1. Participants

Thirty-two participants took part in this sentence-completion study. They were all native speakers of Persian living in Iran. Their age range was 20 to 40 years old (mean=24). Their level of education varied from high school diploma to doctoral degree (PhD/MD). Also, they reported no record of neuro-cognitive deficits, specifically affecting their memory or their reading abilities. Furthermore, they all had normal or corrected-to-normal eye-sight.

2.2.1.1.2. Materials

We used a 2 x 2 design in which we aimed to manipulate the two factors of distance (short: conditions a and c versus long: condition b and d) and predictability (strong predictability: conditions a and b versus. weak predictability: conditions c and d) to investigate the effects of memory and expectation

Conditions ‘a’ and ‘b’ contain complex predicates (noun + light verb) and conditions ‘c’ and ‘d’ contain simple predicates (noun + heavy verb). Before the light/heavy verb in all the conditions, there is a short prepositional phrase in the short conditions, and a relative clause before this prepositional phrase

in the long conditions. The interveners are kept the same across the conditions while the nouns and the verbs differ in complex versus simple predicates.

In total, there were 36 sets of items (mixed with 70 fillers) which were divided into 4 list with a latin-square design. The following is an example of a set of stimuli we used. The word in parentheses is the verb we expected the readers to use when they are given the rest of the sentence.

Complex predicate conditions (noun + light verb):

a. Short distance + strong predictability of the head

Ali a:rezouyee bara:ye man (kard)...
Ali wish-INDEF for 1.S (do-PST)...
'Ali (made) a wish for me...'

b. Long distance + strong predictability of the head

Ali a:rezouyee ke besya:r doost-da:asht-am bara:ye
Ali wish-INDEF that a lot like-1.S-PST for
man (kard)...
1.S (do-PST)...
'Ali (made) a wish for me that I liked a lot...'

Simple predicate conditions (noun + heavy verb):

c. Short distance + weak predictability of the head

Ali shokola:ti bara:ye man (xarid)...
Ali chocolate-INDEF for 1.S (buy-PST)...
'Ali (bought) a chocolate for me...'

d. Long distance + weak predictability of the head

Ali shokola:ti ke besya:r doost-da:sht-am
Ali chocolate-INDEF that a lot like-1.S-PST
bara:ye man (kharid)...
for 1.S (buy-PST)...
'Ali (bought) a chocolate for me that I liked a lot...'

2.2.1.1.3. Procedure

The sentence-completion study was conducted offline. The participants were asked to read the sentences with a natural speed. They were presented the sentence up until the pre-critical region which was the region before the light verb or heavy verb. So, they were instructed to complete the sentences and to write down a verb in relation to either the noun of the complex predicate or the direct object of the simple predicate they were provided earlier in the sentence.

They were allowed to write up to 2 words even though we were interested in the ‘verb’ they predicated. What we measured was the probability at which the participants were able to predict the light or heavy verbs (the critical region) as the continuation of the sentences when they were provided the sentence until the pre-critical region. The prediction accuracy measure was the percentage of predicting a particular verb (the one we used in our stimuli) by the participants.

2.2.1.1.4. Statistical analysis

The data were analyzed in R programming environment (R development Core Team, 2013) using Bayesian generalized linear mixed-effect models which had a binomial link function. In our analysis of the fixed effects, we made use of t-distribution (degrees of freedom = 2) and weakly informative priors. It is worth noting that in Bayesian generalized linear mixed models, we can check for the effect of a specific factor such that the 95 percent interval does not include zero.

2.2.1.2. Results

The average prediction accuracy measure for predicting the identity of the verb (as the head) in the sentence-completion task was 64.46 % in the strong predictability, short condition (condition a) and 59.44 % in the strong predictability, long condition (condition b). Whereas the average prediction accuracy for the verb in the weak predictability conditions was 35.42 % in the short condition (condition c) and 34.03 % in the long condition (condition d). These effects are graphically presented in **Figure 2.1**. The predictability in the short conditions (conditions a and c) was slightly higher than in the long condition (conditions b and d), but this difference was not significant.

A Bayesian generalized linear mixed-effect model indicates that there is a main effect of predictability in this experiment (see **Table 2.1**). This effect is such that the complex predicate conditions are more predictable than the simple predicate conditions.

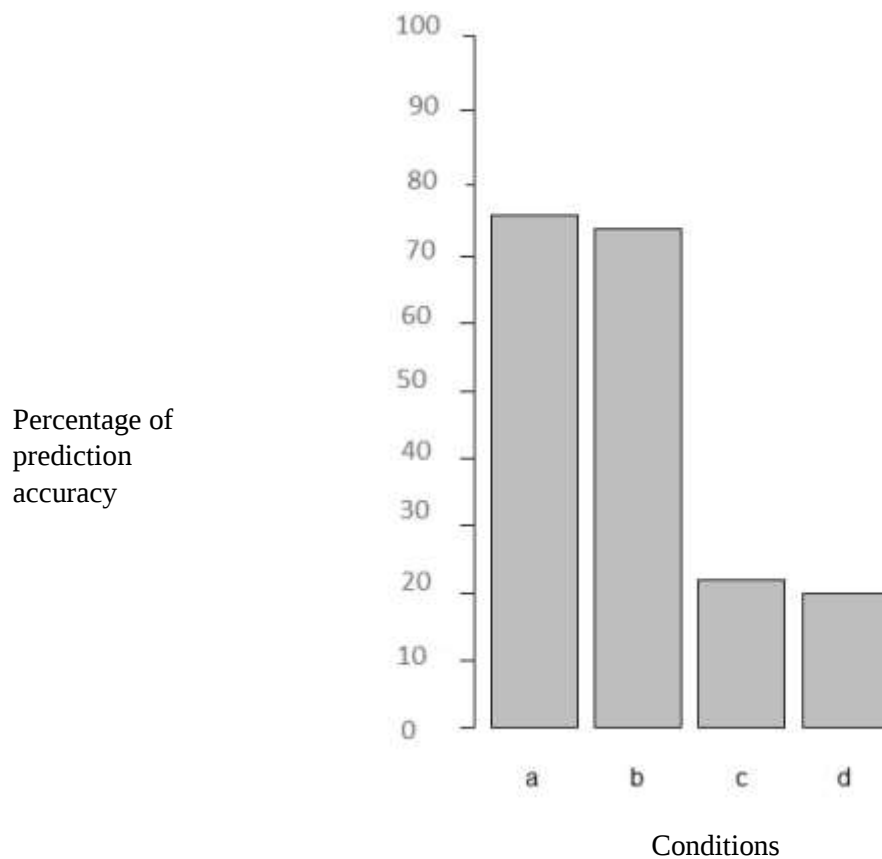


FIGURE 2.1. the mean of the prediction accuracy of the target verb in all conditions in the first sentence completion pre-test measuring the predictability of the light and heavy verbs. In conditions a (complex predicate, short) and b (complex predicate, long) the prediction accuracy was significantly higher than in conditions c (simple predicate, short) and d (simple predicate, long).

TABLE 2.1. Model results from the Bayesian linear mixed model for the first sentence-completion pre-test measuring the predictability of the light and heavy verbs which shows a main effect of predictability as the 95% uncertainty interval includes zero.

Comparison	Mean	Lower	Upper	$P(b < 0)$
Intercept	-0.2055	-0.8375	0.407	0.744
Distance	-0.1584	-0.4709	0.143	0.8548
Predictability	0.9635	0.3184	1.6186	0.0025
Distance × Predictability	-0.1246	-0.4688	0.216	0.766

Shown are the mean and 95% uncertainty intervals, and the probability of the parameter being less than 0.

2.2.1.3. Discussion

The mean percentage of the prediction accuracy in each condition shows that the light verbs used in the complex predicate conditions can be considered relatively more predictable than the heavy verbs in the simple predicate conditions. In the meanwhile, we can argue that, in our particular experimental design, an increased number of intervening items does not lead to more predictability of the upcoming verb.

According to Konieczny (2000), the longer the intervener is, the more additional information we have to predict the upcoming verb leading to shorter reading times in longer conditions. In our materials, the intervening elements did not help to sharpen the prediction of the upcoming verb.

2.2.2. Predictability of the light and heavy verbs II

We conducted a second sentence completion study in order to validate our second set of stimuli in which the nature of the intervener (prepositional phrase) between the noun and the verb was kept the same across the short and long conditions. We aimed at measuring the strength of predictability for the light and heavy verbs we used in the stimuli.

2.2.2.1. Methodology

2.2.2.1.1. Participants

Like in the previous sentence-completion task, thirty-two participants took part in this sentence-completion study, who were different from the participants of the first study. They were all native speakers of Persian language living in Iran. Their age range was 20 to 40 years (mean=25). Their

level of education varied from high school diploma to doctoral degree (PhD/MD).

They reported no record of neuro-cognitive deficits, specifically affecting their memory as well as their reading abilities. They all had normal or corrected-to-normal eye-sight. It is worth mentioning that none of these participants took part in any of the main experiments, namely self-paced reading and eye-tracking, so that we make sure the participants will have the first exposure to the stimuli in the upcoming experiments and cannot guess the pattern of the studies.

2.2.2.1.2. Materials

We used a 2 x 2 design in which we aimed to manipulate the factors of distance (short versus long conditions) and predictability (strong predictability versus weak predictability conditions).

The first two conditions contained complex predicates (noun + light verb) and the last two conditions contained simple predicates (noun + heavy verb). Before the light/heavy verb in all the conditions, there was an intervener. In the short conditions, the intervener was a short prepositional phrase (like the sentence-completion task 1). However, instead of a relative clause, there was a longer prepositional phrase in the long conditions. The interveners were kept the same across the conditions while the nouns and the verbs differed in complex versus simple predicates.

In total, there were 36 sets of items (shuffled with 70 fillers) which were divided into 4 lists with a Latin-square design. The following are examples of a set of stimuli we had. The word in the parenthesis is the verb we expected the readers to produce when they are given the first part of the sentence.

Complex predicate conditions (noun + light verb):

- a. *Short distance + strong predictability of the head*
Ali a:rezouyee bara:ye man (kard)...
Ali wish-INDEF for 1.S (do-PST)...
'Ali (made) a wish for me...'
- b. *Long distance + strong predictability of the head*
Ali a:rezouyee bara:ye doost-e xa:har-e man (kard)...
Ali wish-INDEF for friend-EZ sister-EZ 1.S (do-PST)...
'Ali (made) a wish for my sister's friend...'

Simple predicate conditions (noun + heavy verb):

- c. *Short distance + weak predictability of the head*
Ali shokola:ti bara:ye man (xarid)...
Ali chocolate-INDEF for 1.S (buy-PST)...
'Ali (bought) a chocolate for me...'
- d. *Long distance + weak predictability of the head*
Ali shokola:ti bara:ye doost-e xa:har-e
Ali chocolate-INDEF for friend-EZ sister-EZ
man (kharid)...
1.S (buy-PST)...
'Ali (bought) a chocolate for my sister's friend...'

2.2.2.1.3. Procedure

The sentence-completion study was conducted offline, and the participants were asked to read the sentences in a natural manner and complete the sentences. The sentence was presented up until the pre-critical region which was the region before the light verb/ heavy verb appeared. So, they were expected to write a verb in relation to the noun (either the noun of the complex predicate or the direct object noun of a simple predicate), and We were interested in the first verb they generated after they were provided the pre-critical region.

2.2.2.1.4. Statistical analysis

The data were analyzed in the R programming environment (R development Core Team, 2013) using Bayesian generalized linear mixed-effect models which had a binomial link function. In our analysis of the fixed effects, we made use of t-distribution (degrees of freedom = 2). It is worth noting that in Bayesian generalized linear mixed models, we can check for the effect of a specific factor such that the 95 percent interval does not include zero.

2.2.2.2. Results

The results of the second sentence-completion task were in line with the results of the first sentence completion study such that the average accuracy measure for predicting the identity of the head (i.e., the verb) was 65.28 % in the strong predictability and short condition and 62.85 % in the strong predictability and long condition.

The average prediction accuracy for the verb in the weak predictability conditions was 36.36 % in the short condition and 30.21 % in the long condition. These effects can be seen in **Figure 2.2**. Although the predictability in the short conditions was a bit higher than in the long condition, there was no statistical evidence for the significance of this effect.

As shown in **Table 2.2**, a Bayesian generalized linear mixed-effect model indicates that there is a main effect of predictability in the second experiment. This effect is such that the complex predicate conditions are more predictable than the simple predicate conditions.

TABLE 2.2 | Model results from the Bayesian linear mixed model for the second sentence completion pre-test measuring the predictability of the head. The results indicate a main effect of predictability.

Comparison	Mean	Lower	Upper	$P(b < 0)$
Intercept	-0.142	-0.7587	0.4698	0.677
Distance	-0.16	-0.4042	0.0843	0.9035
Predictability	1.1188	0.4919	1.7495	2e-04
Distance × Predictability	0.0365	-0.2102	0.2727	0.3682

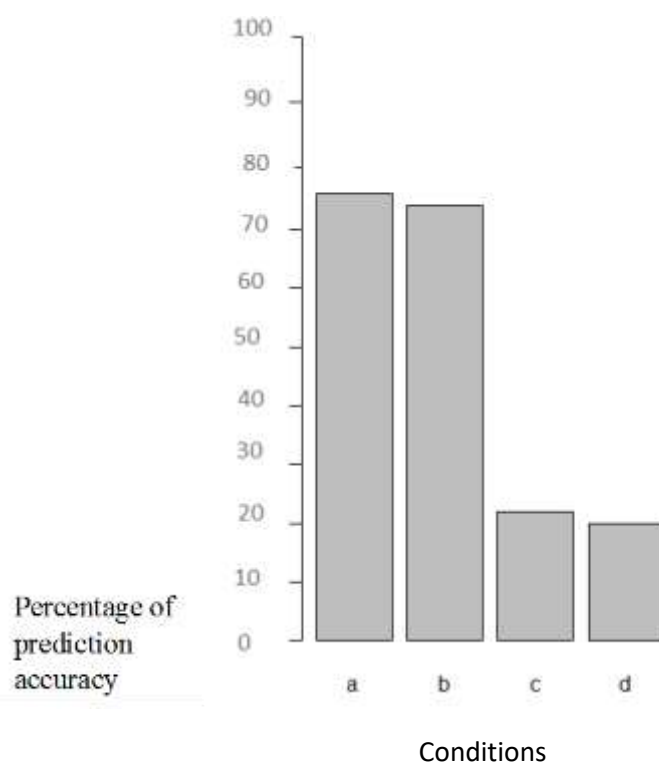


FIGURE 2.2 | the mean of the prediction accuracy of the target verb in all conditions in the second sentence completion pre-test measuring the predictability of the head. In conditions a (complex predicate, short) and b (complex predicate, long) the prediction accuracy was significantly higher than in conditions c (simple predicate, short) and d (simple predicate, long).

2.2.2.3. Discussion

Like in the first sentence-completion study, the average percentage of the predictability in all conditions shows that the light verbs intended for the complex predicate conditions have relatively stronger predictability than the heavy verbs in the simple predicate conditions. It was also shown that increased number of intervening items does not lead to better predictability of the upcoming verb. So here again, Konieczny's (2000) argument that the longer intervening materials sharpen the expectation of the upcoming verb was not supported by our experimental materials.

To summarize, we aimed to investigate the effect of predictability to validate our stimuli to make sure that the light verbs of the complex predicate were more predictable than the heavy verbs of the simple predicate that function as our control conditions. To this aim, we ran two offline sentence-completion tasks in which the participants were asked to predict the verb while they were given the sentence up to (and including) the pre-critical region. The results for both of the studies provided evidence for the effect of predictability in favor of the complex predicate conditions. Compared to the previous experiment (with a combination of prepositional phrase and relative clause as the intervener), this experiment (with only prepositional phrase as the intervener) also confirmed that the light verbs of our second experiment are strongly predictable whereas the heavy verbs are weakly predictable. These two experiments were the first two steps to validate our stimuli. Next, the second pre-test will be described.

2.3. Acceptability of Persian separable complex predicates

As the focus of the current study is long-distance dependency resolution, we need to make sure that the type of constructions we use for our studies (Persian

complex predicates) can be separated. Therefore, we conducted an acceptability rating study to ensure the separability of the noun-verb constructions which were used as the stimuli as a pretest to carefully select our experimental materials. We took into account Karimi-Doostan's (2011) criteria for classifying the complex predicates in terms of separability.

According to Karimi-Doostan (2011), there are three types of Persian complex predicates differentiated on the basis of the pre-verbal element (i.e., the noun with which the light verb is combined to form a complex predicate), and their ability to combine with a light verb. The terms used in this categorization are conventional and coined by Karimi-Doostan and colleagues (2011).

1. predicative verbal nouns

(*anjam*, 'performing', e.g., *anja:m dadan*: lit. 'performing give': 'to perform')

2. predicative nouns

(*latme*, 'damage', e.g., *latme azadan*: lit. 'damage beat': 'to harm')

3. non-predicative nouns

(*gush*, 'ear', e.g., *gush da:dan*: lit. 'ear give': 'to listen to')

Karimi-Doostan (2011) proposes that these three groups are distinguished based on whether or not (1) the preverbal element (the noun) has internal argument structure, i.e., if it refers to an action or event; and (2) it has full-fledged noun features, i.e., if it can be plural; it is selected by adjectives, determiners, demonstratives, prepositions and Ezafe particle⁵; or it can get the function of subject or object. Predicative verbal nouns, as the first category, possess an argument structure whereas they lack some noun features (e.g., adjectives cannot be attributed to them) which means that they do not behave like nouns morphosyntactically. Predicative nouns, the second category, meet

⁵ Ezafe is a grammatical particle in Iranian languages that links two words together. The most common applications of Ezafe are to link a noun to an adjective and to act as a possessive marker. This particle is usually glossed as 'ez'.

both criteria as they have an internal argument structure as well as noun features. Lastly, the non-predicative nouns have all the noun properties whereas they do not have an internal argument structure. Karimi-Doostan (2011) argues that only the second group (predicative nouns) can be separated from their light verb in a complex predicate.

Below a more elaborated version of the examples for the three types in different contexts is provided (adapted from Karimi-Doostan, 2011). According to Karimi-Doostan (2011), only 1.a. and 3.a. (among group 1 and 3) are acceptable sentences in Persian whereas all of the sentences in group 2 are considered acceptable.

Here we elaborate on the following examples for each group to show why only the separability of the second group is acceptable for Persian native speakers from a grammatical point of view. In case of the predicative verbal noun ‘anja:m’, lit. ‘performing’ which forms a complex predicative with the light verb ‘da:dan’, lit. ‘to give’, only the first condition where the two parts of the complex predicate are adjacent is acceptable, and the rest of the conditions of this group in which the noun and the light verb are somehow separated (by attributing an adjective, demonstrative adjective, ‘ra’ accusative marker, prepositional phrase, wh-word, or relative clause to it) are not grammatically acceptable.

As for the second group, all of the conditions for the complex predicate ‘latme zadan’, lit. ‘damage + to hit’ (either adjacent or separated) are acceptable enough for the Persian speakers even though this separation might not be the preferred structure specially in formal register. Similar to the first group, the third group non-predicative nouns as in ‘gush kardan’, lit. ‘ear + to do’ does not allow for the separability of the parts of complex predicates as all the conditions (except for the first one, i.e., adjacent one) are considered unacceptable for the native speakers.

1. Predicative verbal noun

- a. *Ali ka:rash-ra: anja:m da:d.*
 Ali work-his-dom performing give-pst
 ‘Ali did his work.’
- b. **Ali anja:m-e xub-i (az) (be) ka:rash da:d.*
 *Ali performing-ez good-indef (of) (to) work-his give-pst
 *‘Ali had a good performance in his work. /Ali did his work well.’
- c. **Ali /in /anja:m-ra: (/az) (be) ka:r-as~ da:d.*
 *Ali this performing-dom (of) (to) work-his give-pst
 *‘Ali did his work.’
- d. **anja:m-i ke Ali (az) (be) ka:rash da:d*
mofid bud
 *performing-indef that Ali (of) (to) work-his give-pst
 useful was
 *‘Ali is performing his work was useful.’
- e. **Ali che anja:m-i (be) ka:rash da:d?*
 *Ali what performance-indef (to) work-his give-pst
 *‘What sort of performance did Ali have in his work?’
- f. **in anja:m-ra: Ali (be) ka:rash da:d.*
 *this performing-dom Ali (to) work-his give-pst
 *‘Ali did his work.’

2. Predicative noun

- a. *tegarg be ba:q-e man latme zad.*
 hail to garden-ez 1.s damage beat-pst
 ‘The hail damaged my garden.’
- b. *tegarg latme-ye bad-i be ba:q-e man zad.*
 hail damage-ez bad-indef to garden-ez 1.s beat-pst
 ‘The hail caused bad damage to my gardens./The hail damaged my garden badly.’
- c. *tegarg-e diruz /in latme-ra: be ba:q-e*
 hail-ez yesterday this damage-dom to garden-ez
man zad
 1.s beat-pst
 ‘The yesterday’s hail caused this damage to my garden’
- d. *latme-/i ke tegarg be ba:q-ha: zad*

damage-indef that hail to gardens beat-pst
jobra:nna:pazir ?ast.
 irretrievable is
 ‘The damage caused by the hail to the gardens is irretrievable.’

e. *Ali che latme-i be shoma: zad*
 Ali what damage-indef to you beat-pst
 ‘What loss did Ali cause to you?’

f. *in latme-ra: tegarg-e diruz be ba:q-e*
 this damage-dom hail-ez yesterday to garden-ez
man zad.
 1.s beat-pst
 ‘The yesterday’s hail caused this damage to my garden.’

3. Non-predicative noun

a. *Ali be ra:dyo gush kard*
 Ali to radio ear do-pst
 ‘Ali listened to the radio.’

b. **Ali be ra:dyo gushe xubi kard*
**Ali to radio ear-ez good do-pst*
 *‘Ali listened good to the radio.’

c. **Ali in gush-ra: be ra:dyo kard*
**Ali this ear-dom to radio do-pst*
 *‘Ali did this listening to the radio.’

d. **gush-i ke Ali be ra:dyo kard va:zeh nabud.*
**ear-indef that Ali to radio do-pst clear wasn_t*
 *‘The listening that Ali did to radio was not clear.’

e. **Ali che gush-i be ra:dyo kard?*
**Ali what ear-indef to radio do.pst*
 *‘What listening did Ali do to the radio?’

f. **in gush-ra: Ali be ra:dyo kard*
**this ear-dom Ali to radio do-pst*
 *‘Ali did this good listening to the radio.’

In this section, we aim to measure how acceptable it is for Persian speakers to separate parts of a complex predicate. We base our experimental design on Karimi-Doostan's (2011) criteria of separability which were discussed earlier, and we want to verify whether predicative nouns (as the noun of a complex predicate) allow the dependency to get separated such that a light verb can be delayed by intervening materials. Based on his criteria, we predict that only the complex predicates whose nominal part is of 'predicative noun' type can be separable.

2.3.1. Methodology

2.3.1.1. Participants

There were fifty participants who were all Persian native speakers (different from those who participated in either of the sentence-completion studies). Just like the participants in the sentence-completion studies, they were between 20 to 40 years old (mean=25), and they had minimum education level of high school diploma up to doctoral degree (PhD/MD), without any record of neuro-cognitive deficits, and with normal or corrected-to-normal eye-sight.

2.3.1.2. Materials

The stimuli were designed according to Karimi-Doostan's (2011) criteria for the separability of a Persian complex predicate. This separability depends on the noun not on the light verb. In other words, if the noun has the full-fledged noun feature (for example, adjectives or demonstratives can be attributed to it) and an internal argument structure (referring to an action or event), then it can be separated from its light verb. However, predicative verbal nouns and non-predicative nouns do not allow this separation.

In our design, we had three conditions (a) predicative verbal nouns, (b) predicative nouns, and (c) non-predicative nouns. Each condition contained 36 sentences in random order, and the intervener was kept the same across conditions.

To make it difficult for the participants to recognize the pattern of the test, we included 60 fillers, half of which were correct (hence acceptable) Persian sentences, and the other half were incorrect, thus unacceptable. Below is an example of the materials (with the same order as described in section 2.1.2.). In the first condition, '*ebra:z kardan*' (lit. stating + to do: 'to state') is a complex predicate whose noun is of predicative verbal type and cannot be separated by the propositional phrase 'be man' (lit. to me). An example for the second condition is '*komak kardan*' (lit. help + to do: 'to help') which is acceptable to be separated by the same prepositional phrase. In the last condition, '*a:tash zadan*' (lit. fire + to set: to set fire) cannot be separated, similar to the first condition. We will test to see if this criteria of separability holds in an acceptability judgement task by Persian native speakers.

a. Complex predicate with predicative verbal noun:

***ebra:z kardan*, lit. stating + to do: 'to state'**

**Maryam ebra:z-i be man kard...*

*Maryam stating-INDEF to 1.S do-PST...

*'Maryam stated (something) to me/ said to me...'

b. Complex predicate with predicative noun:

***komak kardan*, lit. help + to do: 'to help'**

Maryam komak-i be man kard...

Maryam help-INDEF to 1.S do-PST...

'Maryam helped me with something...'

c. Complex predicate with non-predicative noun:

***a:tash zadan*, lit. fire + to set: 'to set fire'**

**Maryam a:tash-i be man zad...*

*Maryam fire-INDEF to 1.S beat-PST...

*'Maryam set fire to me...'

2.3.1.3. Procedure

The materials were distributed via Online Google forms. The participants were instructed to read the sentences carefully and to rate them on a seven-point rating scale: from 1 (which was considered the most acceptable) to 7 (which meant the least acceptable). Each participant saw all the items, but no participant saw the list in the same order as it was shuffled via Google automatically each time.

2.3.1.4. Statistical analysis

To analyze the acceptability data, R statistical and programming software (R development Core Team, 2013) was used. The statistical analysis was done by getting the average acceptability ratings for all the ratings across the three groups of conditions which were calculated and compared respectively.

2.3.2. Results

The average acceptability ratings for the three conditions were calculated, and the results showed that the complex predicates which included predicative verbal nouns (as the noun dependent of the light verb) had 3.23 mean acceptability which means that the participants did not consider the separated complex predicates of the first type as grammatical. The complex predicates which were formed with the predicative nouns had the highest average of acceptability rating (6.08), hence, the overall rating was in favor of their grammaticality. Finally, the complex predicates that contained non-predicative nouns as the nominal had an average acceptability rating of 3.12 which implies that such sentences are not accepted as grammatical by the native speakers of Persian.

Therefore, the second category with complex predicates that contained predicative nouns had the highest acceptability when the light verb gets delayed. The results are shown in **Table 2.3**.

TABLE 2.3 | Acceptability rating of the three types of nominals in complex predicates

<i>Type of the nominal</i>	<i>Example</i>	<i>Average acceptability rating</i>
<i>Predicative verbal noun</i>	<i>anja:m dadan:</i> lit. ‘performing give’, ‘to perform’	3.23
<i>Predicative noun</i>	<i>latme zadan:</i> lit. ‘damage beat’, ‘to harm’	6.08
<i>Non-predicative noun</i>	<i>gush da:dan:</i> lit. ‘ear give’, ‘to listen to’	3.12

2.3.3. Discussion

According to the results of the acceptability rating study which was conducted as a pre-test to validate the acceptability of the materials used for the experiments in Chapters 3 and 4, we can conclude that Karimi-Doostan’s (2011) criteria of separability in Persian complex predicate is valid. The results also confirmed that the complex predicates in which the noun part has both full-fledged noun features and internal argument structure, that is, it refers to either an action or an event, can be separated by the intervening materials while still being considered as an acceptable structure to native Persians. Complex predicates in which the noun part lacked either of these conditions proved to be less acceptable to the native speakers. Therefore, we can conclude that, for the predicative items, the structures we are interested in, that is, the non-adjacency of the light verbs and its dependent noun, are acceptable. In other words, it is acceptable for Persian native speakers that the

light verb is postponed on condition that the nominal is of a ‘predicative noun’ type, as described by Karimi-Doostan (2011). Still, the figures of 3.23 and 3.12 indicate that these sentences (in the first and the third conditions) can be acceptable for some Persian speakers. The reason for this might be the strong diglossic situation in Persian where there is a big difference between formal and colloquial forms, and probably these participants considered the sentences as acceptable from colloquial point of view, whereas the stimuli we used (second group) are accepted in both formal and colloquial versions. It will be interesting to add this factor in a separate study to investigate the effect of register in Persian. However, such a study is beyond the scope of the current dissertation and the research questions we are interested in. The main motivation for us to conduct this pretest was to make sure that the stimuli we selected for the further studies are acceptable enough for the native speakers.

2.4. Comparing adjacent and separated complex predicates in Persian and Hindi dependency corpora

As for the factor of distance in our experimental materials, we compared short conditions in which the parts of the complex predicates are separated with a short intervener versus long conditions in which the two parts are separated with longer intervening materials. Increasing distance, as predicted by Surprisal (Levy, 2008), can lead to facilitation when the distance results in decreasing the number of the possible parses. In order to have facilitation in the long condition (as compared to the short condition), the conditional probability of the light verb after the relative clause and the prepositional phrase must be higher than the conditional probability of the light verb in the condition which only has a short prepositional phrase as the intervening material.

The results of our sentence completion studies predict that participants highly expect a light verb (with probability near 1) when they read the noun of the complex predicate in the short condition. However, when the intervener is long, the word after the noun (the relative marker) starts a relative clause which is in contrary to the reader's expectation. So, the reader expects to see the light verb right after the relative clause is finished. However, the relative clause is still followed by a prepositional phrase. As a result, the reader is surprised again and expects to read the light verb when the prepositional phrase ends. This led us to measure the conditional probability of the light verb after the intervener using Persian Corpora (Seraji, 2012, 2015).

For the purpose of the study, we used a Persian dependency treebank corpus (Seraji, 2015), and extracted all the noun-light verb constructions, looking for the various number of intervening words/ phrases that preceded the light verb. Furthermore, we checked for the frequency of separating the noun and the light verb in Persian complex predicates and compared this frequency with similar situation in Hindi, described by Husain et al. (2014). The aim of doing this corpus study was to understand to what extent the adjacency of the complex predicate parts is preferred in these two languages.

In this section, we will explain how we got insight from the corpus data before starting our main experiments. In the first place, we extracted all the sentences in which light verbs were used from Persian corpora in order to have an estimation of how the conditional probabilities change in the separable complex predicates as a function of distance. Secondly, we compared the average distance between a noun and a light verb versus a noun and a heavy verb in Hindi and Persian languages. The aim of doing the second analysis was to investigate how rare it is to separate the noun from the verb in each languages and whether this affects our final results of the main experiments. The motivation for this comparison is that we can later compare the nature of

the two languages in our discussion if we encounter difference results in our next experiments (i.e., self-paced reading and eye-tracking) despite the similarity in experimental stimuli.

2.4.1. Methodology

2.4.1.1. Materials

For both corpus analyses, we extracted the data from the Persian dependency treebank by Seraji (2015). For Hindi data, we used Hindi dependency treebank by Bhatt and colleagues (2009).

2.4.1.2. Procedure

To target our first question regarding the extent to which distance affects the conditional probabilities, the proportion of the cases in which the verb came after an intervening phrase were counted (e.g., the sentence ‘*Mary in the afternoon left*’ contains one intervening phrase which is the prepositional phrase ‘*in the afternoon*’). Also, in order to have a word by word view of the intervening materials, we did the same analysis with the number of intervening words (instead of phrases).

As for the second question about the preference of adjacent or separated complex predicates, the average distance between a light verb and its nominal was calculated using the number of intervening phrases. Also, the average distance between a heavy verb and its object was calculated. The results from Hindi and Persian were compared and will be discussed in the results section.

2.4.1.3. Statistical analysis

We analyzed the data we extracted from the Persian and Hindi corpus using R program (R development Core Team, 2013). First, the conditional probabilities were calculated according to the number of intervening words and phrases. Second, the average distance between a light or heavy verb and its dependent noun or object was computed.

2.4.2. Results

The results indicated that, as shown in **Table 2.4**, the conditional probability of appearing the upcoming verb appearing is always high. However, it goes to 1 when the distance between the light verb and its dependent noun (with which it forms a complex predicate) increases.

The same calculation was done using the number of words, instead of the number of phrases as the metric. The results, as shown in **Table 2.5**, is highly similar to the situation where the intervening phrase was considered as the metric of calculation.

TABLE 2.4 | The conditional probability of a light verb appearing given the complex predicate noun and n intervening phrases between the noun and the light verb.

n Intervening phrases	Probability of verb
0	$3826/4003 = 0.95$
1	$131/133 = 0.98$
2	$28/31 = 0.90$
3	$5/5 = 1$
4	$2/2 = 1$
6	$1/1 = 1$

TABLE 2.5 | The conditional probability of a light verb appearing given the complex predicate noun and n intervening words between the noun and the light verb.

n Intervening words	Probability of verb
0	$3826/4003 = 0.96$
1	$104/104 = 1$
2	$36/39 = 0.92$
3	$4/5 = 0.8$
4	$9/10 = 0.9$
5	$3/3 = 1$
6	$3/3 = 1$
7	$1/1 = 1$
8	$2/2 = 1$
10	$2/2 = 1$
12	$1/1 = 1$
13	$1/1 = 1$
14	$1/1 = 1$

As our experimental design is very similar to the study on Hindi by Husain and colleagues (2014), we conducted a corpus analysis based on Persian (Seraji, 2015) and Hindi (Bhatt et al., 2009) dependency treebanks in order to find out to what extent the adjacency of the elements in a complex predicate is preferred in either of these two languages. As shown in **Table 2.6**, the respective results of Hindi data indicated that the average distance (i.e., number of intervening phrases) between a noun (as direct object) and its corresponding heavy verb in a simple predicate is 0.82. However, the mean distance between a noun and its light verb in complex predicate was 0.07 which means that in Persian complex predicates the adjacency and shorter distance is preferred.

According to Persian dependency treebank (Seraji, 2015), the mean of distance between a noun (as direct object) and its corresponding heavy verb is 2.48. However, the average distance between a light verb and its dependent nominal in Persian is 0.05.

TABLE 2.6 | Average distance between an object-heavy verb versus a noun-light verb construction based on Persian and Hindi dependency treebanks

<i>Dependency Corpus</i>	<i>Noun – Heavy verb</i>	<i>Noun-Light Verb</i>
<i>Hindi Corpus (Bhutt et al., 2009)</i>	0.82	0.07
<i>Persian Corpus (Seraji et al., 2015)</i>	2.48	0.05

2.4.3. Discussion

According to the corpus data, the conditional probability of expecting the head (i.e., here the light verb) is often high, and it gets further than zero when the distance (i.e., the intervening materials as words or phrases) between the light verb and its corresponding noun increases. However, these results do not provide us with substantial evidence about the predictions of locality and expectation with respect to the particular design of our experiments in which predictability (in strong versus weak conditions) plays an essential role side by side the factor of distance investigated in this corpus study.

Also, the comparison of Persian and Hindi dependency treebank suggests that a larger distance is allowed in the word order of Persian simple predicates as compared to Hindi. However, when it comes to complex predicates, the adjacency of a light verb and its noun in Persian language is preferred over its

separation when we compare it to the situation in Hindi which is more tolerant about this separation. Nevertheless, as validated in the acceptability rating study, this separation is still acceptable and considered grammatical in some particular cases.

2.6. General discussion

The set of studies presented in this chapter served as the pretests to validate the stimuli we used in the self-paced reading and eye-tracking experiments which will be explained in the following chapters. First, the two sentence-completion tasks ensured the particular manipulation we planned to have in our design: the light verbs of the complex predicate were strongly predictable whereas the heavy verbs of the simple predicate conditions were weakly predictable. Second, the acceptability rating study helped us to confirm the criteria of separability we used in Persian complex predicates despite the fact that the adjacency of the elements in a complex predicate is preferred. In the third study, we used the Persian corpora to calculate the change in conditional probability of the separable complex predicates as a function of distance. The results indicated that the conditional probability of the upcoming verb appearing is always high, and it gets closer to 1 as the distance between the head (i.e., light verb) and its dependent (i.e., noun) increases. In another corpus analysis, we used Persian and Hindi dependency treebanks to calculate the average distance between the noun and light verb versus the direct object and its heavy verb. The respective results suggest that the adjacency of complex predicates is preferred more in Persian than in Hindi. Taking into account all of these results, we conducted the two self-paced reading and the two eye-tracking experiments to investigate the role of memory and expectation in resolving a particular long-distance dependency: Persian complex predicates.

Chapter three

Long-distance dependency resolution in Persian (I):
evidence from self-paced reading studies on separable
complex predicates

3.1. Introduction

In this chapter, we investigate the long-distance dependency resolution in Persian complex predicates through two masked self-paced reading experiments. In the literature of sentence processing, it is widely believed that the distance in a long-distance dependency determines the accuracy and speed of its resolution (Fodor, 1978; Gibson, 2000; McElree et al., 2003; Lewis and Vasishth, 2005; Levy, 2008); however, what remains a controversial point is how lengthening the distance (i.e., intervening materials) might affect this accuracy and speed. In this regard, there are two seemingly contradicting

explanations, one of which is based on memory and the other one on expectation. In the current research, we aim at finding either or both of these effects studying Persian separable complex predicates. To our present knowledge, this is the first psycholinguistic study in Persian language that targets locality and expectation accounts.

3.1.1. Memory-based accounts

The memory-based explanations consist of two major accounts: the Dependency Locality Theory (Gibson, 1998, 2000) and the Activation-Based Model (Lewis and Vasishth, 2005; Lewis et al, 2006). According to Dependency Locality Theory, the processing difficulty at resolving a long-dependency depends on integration cost and storage cost. Integration cost refers to the increasing number of discourse referents in the intervener. Storage cost refers to the number of predicted heads that leads to increasing the processing difficulty. As a result, there is a slow-down at the time of resolution when the number of intervening words between the head and the dependent goes up. This theory is only relevant for sentence comprehension processes; however, the Activation-Based Model has a broader cognitive approach. This model puts aside the storage cost of Dependency Locality Theory while the effects of interferences are still considered (Van Dyke and Lewis, 2003; Lewis et al., 2006; Van Dyke and McElree, 2011).

The activation-based model argues that the linguistic items in memory are affected by interference from other linguistic materials. Therefore, it regards the source of difficulty in retrieving the non-local argument (i.e., an argument which is not close to its head) whose access can be affected by two factors: decay of the items in working memory (which means the increased time passed from the moment the argument was actually encoded and proposes that

memory fades in the passage of time) and similarity-based interferences (which are distractors that share similar features with the target argument). The idea comes from the original studies on working memory based on which the items that we are supposed to remember are more quickly forgotten when they are followed by the similar items in some aspects (Shulman, 1970; Waugh and Norman, 1965). Hence, increasing similarity can make things more difficult. In a recent study, Nicenboim (2014) argues that individuals' working memory capacity affects the processes involved in the dependency resolution, that is, the working memory capacity modulates the reading times and regressions at the head of long-distance dependencies, as predicted by both memory-based accounts (see also, Kings and Just, 1991; Unsworth and Engle, 2007; Kuperman and Van Dyke, 2011; Prat, 2011; Traxler et al., 2012; Caplan and Waters, 2013; among others).

3.1.2. Expectation-based accounts

Another stream of research, so-called 'antilocality', is concerned with the role of prediction that has always been a major interest in the theories of cognition and language processing (Kutas et al., 2011). A classic study by Marslen-Wilson (1973) showed that the majority of 'constructive errors' made by subjects in a speech shadowing task were 'both semantically and syntactically congruent with the preceding context'. This study was one of the earliest to demonstrate the role of prediction in human sentence processing. On this account, previous phrases in a sentence influence the processing of upcoming unseen material. Investigations on SOV languages (where the argument of VP is presented pre-verbally) like German (Konieczny, 2000), Hindi (Vasishth, 2003; Vasishth and Lewis, 2006, Husain et al., 2014), and Chinese⁶ (Jäger et

⁶ Generally, Chinese is considered an SVO language. However, in standard Mandarin SOV word order is tolerated as well.

al., 2014) among many others proposed that increasing distance can lead to a speedup of retrieving the head at the point of dependency resolution. This can also be justified by the activation-based model as the intervener can strengthen the appearance of the following head by activating it through modifying it, i.e., determining the time, person, etc (Vasishth and Lewis, 2006), so this facilitation is because the head has already been preactivated.

A prominent account called ‘Surprisal’ (Hale, 2001, Levy, 2008) assumes that the comprehenders’ Surprisal increases when a parser is required to build some low probability structure. Surprisal theory has been successful in explaining the so-called ‘anti-locality’ effects (Levy, 2008; Levy and Keller, 2013). This effect is seen as a facilitation in processing at the head (eg. verb) as its distance with respect to its prior dependent (eg. an argument) increases. Surprisal theory explains this facilitatory ‘anti-locality’ effect by proposing that expectation of encountering an upcoming head is sharpened with more intervening phrases, as adding more phrases has the effect of constraining the upcoming material compatible with previous context. Hence, when the reader eventually reaches the head, a facilitation in processing occurs as the comprehender effectively expects the appropriate head. Note that Levy (2008) makes the distinction between expecting the ‘identity’ or/and ‘position’ of the upcoming head. Surprisal predicts facilitation under both kinds of expectation.

3.1.3. Mixed account

More recent work (eg. Staub, 2010; Vasishth and Drenhaus, 2011; Levy and Keller, 2012; Levy et al., 2013; Husain et al., 2014) has shown that in order to account for the cross-linguistic experimental results, both these theories must be taken into account. For example, Staub (2010), in his eye-tracking study investigating processing difference in English object versus subject relative

clauses ,finds evidence for both expectation based processing and locality constraints. But these opposing effects are seen at different regions in object relatives.

While evidence for the Surprisal theory is seen at the first noun after the relative pronoun, the locality-based effect is seen as processing slowdown at the relative clause verb. Vasisht and Drenhaus (2011) and Levy and Keller (2013) have argued that locality effects may appear when there is a high load of WM, whereas, anti-locality effects may be present when the load is low. As opposed to this, in a recent study, Husain et al. (2014) argue that strong expectation of the head cancels locality effect and locality manifests itself only when expectation strength is weak. Also, Levy and colleagues (2013), who studied Russian relative clauses, conclude that dashed expectations lead to slowdown, i.e, building a rarer structure is more demanding than building a more frequent structure.

As Nicenboim (2014) suggests, if both Dependency Locality Theory and expectation-based accounts come to stage together, we may see decreasing locality effects (with increase of working memory capacity) until the point that anti-locality effects (as a result of Surprisal) increase, yet the facilitation should not go further than a certain level. Therefore, all of these studies suggests that memory-based and expectation-based accounts do not necessarily contradict each other and both types are needed in order to explain the experimental effects.

3.1.4. Persian complex predicates

Complex predicates are interesting constructions that display both syntactic and lexical features, i.e on the one hand, they participate in the syntactic processes and some of them can be separated by different interveners whereas

they often have a non-compositional meaning (Amtrup and Megerdooian, 2007). These constructions can be used to study two contradicting accounts of locality and expectation by lengthening the intervener between the two part of the separable complex predicates.

3.1.5. Predictions for the current studies

According to self-paced reading studies, locality effects occur as a result of longer reading times (among others : Gibson, 2000; Grodner and Gibson, 2005; Bartek et al., 2001), and antilocality effects occur as a result of shorter ones (Konieczny, 2000; Levy, 2008; Vasishth and Lewis, 2006). Also, based on the Husain et al. (2014) results, we expected that increasing noun-verb distance leads to faster reading time at the position of the verb in the strong predictable conditions, but slower reading time in the weak predictable conditions. Thus, we expect to obtain a cross-over interaction. Memory based accounts (Just and Carpenter, 1992; Gibson, 2000; Lewis and Vasishth, 2005) predict that increasing distance leads to a slowdown at the verb. These accounts make no predictions about the strength of predictability.

There are two alternative predictions for the expectation account, depending on how one operationalizes expectation. First, if sentence completion probabilities are a reasonable proxy for conditional probabilities—and the previous research reported above (Husain et al., 2014; Levy and Keller, 2013; Jäger et al., 2015) suggests that they may be—then we predict (a) no difference in reading time at the verb as a function of distance, and (b) faster reading time at the verb in the strong predictable conditions than the weak predictable conditions. Prediction (a) arises because, in the sentence completion data, we saw no effect of distance on the predictability of the upcoming verb, in either the strong or weak predictability conditions; prediction (b) arises due to the

difference in predictability of the exact verb that we see in the strong versus weak predictability conditions (see the results of the sentence completion studies in chapter 2).

An alternative prediction of the expectation account is that increasing distance facilitates processing at the verb position. Surprisal predicts facilitation with increasing distance whenever distance causes the number of possible parses to decrease; this decrease in the number of possible parses leads to the probability mass being reassigned among the remaining parses. In our materials, when a participant reads the noun in the noun-verb complex predicate, they are expecting the light verb with high probability (nearly 1). However, in the long distance condition, the next word begins a relative clause; this leads to an expectation that the light verb will appear after the relative clause verb. But what appears after the relative clause verb is a prepositional phrase that modifies the upcoming light verb. For a facilitation to be predicted in this long distance condition by Surprisal, it is the case that the conditional probability of the light verb following the relative clause and prepositional phrase is higher than the conditional probability of the light verb in the short-distance (prepositional phrase) condition.⁷

Regarding the strong versus weak predictability conditions, note that the expectation account of Hale (2001) and Levy (2008) does not expect that processing is facilitated when the exact identity of the upcoming verb is predicted (in the complex predicate conditions), compared to the case when just ‘some’ verb is predicted (in the simple predicate conditions). This is because Surprisal is usually calculated using the conditional probability of the grammatical function (i.e., the verb here) given preceding context, and this will be the same in both the strong and weak predictability conditions. However, it is possible to subsume the difference between strong and weak

⁷ For more information and examples, please refer to the sentence-completion tasks in chapter 2.

predictability under the Surprisal account by reframing the conditional probabilities in terms of the exact identity of the verb. In this case, the expectation account would predict faster reading times in the strong predictability conditions compared to the weak predictability conditions, regardless of distance.

In experiment 2, the distance manipulation involves lengthening the prepositional phrase. There are two predictions of Surprisal. One is that Surprisal predicts no difference at the verb; this is because the end of the prepositional phrase raises a strong expectation for a verb, and this strong expectation for a verb would be the same in both the short and long prepositional phrase conditions. Another alternative prediction of Surprisal is that lengthening the prepositional phrase leads to a facilitation. This prediction holds if increasing distance, counted in terms of the number of intervening words, generally increases the predictability of the upcoming verb. In **Table 3.1**, you can find the summary of the predictions for the upcoming experiments.

Table 3.1. Summary of the predictions for distance and predictability in the framework of memory-based and expectation-based accounts

	Regarding distance	Regarding predictability
Memory-based	Slow-down at the verb	No prediction
Expectation-based	Either no effect of distance, or a facilitation at the verb as a function of distance	Speed-up at the verb in the strong predictability conditions

In short, regarding the distance manipulation, the expectation account predicts either no effect or a facilitation at the verb as a function of distance; and regarding the predictability manipulation, the expectation account (appropriately formulated to include the conditional probability of the exact lexical item predicted) predicts a main effect of predictability.

3.2. Locality and expectation in Persian: evidence from self-paced reading

In the following sections, the first self-paced reading study will be explained in details. The manipulation of this experiment involves a prepositional phrase and a relative clause that act as the intervening materials for the separable complex predicates.

3.2.1. Methodology

3.2.1.1. Participants

In this experiment, forty-two adults participated. They were all between 17 and 40 years old (with mean of 24 years old), lived in Tehran (Iran), and were all native speakers of Persian. They had normal or corrected-to-normal eyesight with no known history of neurophysiological and cognitive disorders. There were no participants from the pretest studies (explained in the previous chapter) among them.

We made sure that the participants were unaware of the purpose of the study which was conducted in accordance with Helsinki Declaration. Letters of consents were obtained from all of the participants.

3.2.1.2. Materials

The materials consisted of 36 sets of items with a 2x2 factorial design. Therefore, in the whole experiment we had 144 sentences which were latin-squared across the four conditions such that the participants only saw one condition of each item.

In our design, the two factors of predictability strength and distance were manipulated. As for the first factor, manipulation was done between the noun (either the nominal of the complex predicate in conditions ‘a’ and ‘b’ or the direct object of the simple predicate conditions in ‘c’ and ‘d’) and its verb (light verb in the complex predicate conditions and heavy verb in the simple predicate conditions) such that the light verbs were highly predictable and the heavy verbs were highly unpredictable. This predictability was judged in the first pre-test which was discussed in chapter 2. Regarding distance manipulation, an intervener was inserted between the noun and the verb such that conditions ‘a’ and ‘c’ with a short prepositional phrase as the intervening material are shorter than conditions ‘b’ and ‘d’ which had a relative clause in addition to the prepositional phrase as the intervener. The sentences were exactly the same as the ones used in the sentence-completion tasks in chapter 2.

In order to mask the main experimental conditions, we included 100 fillers with different syntactic structures, so that the participants could not recognize our designed pattern. Below an example for each condition is given. It is worth mentioning that the critical region was the light verb (in this example ‘kard’) versus the heavy verb (in this example ‘xarid). The main experimental sentence was always continued by a coordinate structure, so that the critical region would not fall at the end of the sentence.

a. Short distance + strong predictability of the head

Ali a:rezouyee bara:ye man kard...
Ali wish-INDEF for 1.S do-PST...
'Ali made a wish for me...'

b. Long distance + strong predictability of the head

Ali a:rezouyee ke besya:r doost-da:asht-am
Ali wish-INDEF that a lot like-1.S-PST
bara:ye man kard...
for 1.S do-PST...
'Ali made a wish for me that I liked a lot...'

c. Short distance + weak predictability of the head

Ali shokola:ti bara:ye man xarid...
Ali chocolate-INDEF for 1.S (buy-PST)...
'Ali bought a chocolate for me...'

d. Long distance + weak predictability of the head

Ali shokola:ti ke besya:r doost-da:sht-am
Ali chocolate-INDEF that a lot like-1.S-PST
bara:ye man xarid
for 1.S buy-PST...
'Ali bought a chocolate for me that I liked a lot...'

All experimental sentences as well as the fillers were followed by true-false comprehension-check questions which targeted different thematic roles in the sentence. The distribution of these sentences was such that half of them were false and the other half was true. All materials can be found in the appendix of the current dissertation.

3.2.1.3. Procedure

The individuals were tested in a silent room in front of a PC. They were explained the procedure of the experiment thoroughly and instructed to read the sentences that appeared on the screen at a normal pace and to answer the comprehension-check questions that followed them. Also, they were shown a set of 5 practice items before the actual experiment started. The stimuli were

presented on a single line with the font of 22 pt Persian Arial on Linger software (<http://tedlab.mit.edu/~dr/linger/>) with a ‘moving window’ paradigm in which the participants had to read the sentences word by word successively as they pressed the space button on the keyboard. So, the previous word was masked and the new word appeared on the screen.

After each sentence, a true-false comprehension check question appeared which the participants had to answer based on the sentence they read before by pressing the two previously-specified buttons. These questions targeted different thematic roles of the sentence to ensure that the participants paid attention to the complete sentence. The whole experiment took on average 30 minutes for each individual.

3.2.1.4. Statistical analysis

The data were analyzed in R programming environment (R Development Core Team, 2013). In order to confirm the robustness of our results, we conducted the analysis with two different statistical methods: Linear Mixed Models based on rePCA function (Bates et al., 2015) and Bayesian hierarchical (so-called linear mixed) models using Stan (Stan Development Team, 2014; Gabry and Goodrich, 2016). In the following section, the two statistical methods will be presented based on the analysis of the results.⁸

In the first analysis, we used linear mixed-effects models (LMMs; Pinheiro and Bates, 2000; Bates et al. 2015). For large samples, the t-distribution approximates the normal distribution and an absolute value of t larger than 2 indicates a statistically significant effect at $\alpha = 0.05$. Sum contrasts were

⁸ All data and code are available from

<http://www.ling.unipotsdam.de/~vasishth/code/SafaviEtAl2016DataCode.zip>

used to code main effects and interactions. In addition, a nested contrast was defined for a secondary analysis in order to look at the effect of distance in complex predicates versus the control conditions separately; these were also coded as sum contrasts.

For the reading time data, the most complex model possible given the data and the design was chosen based on the rePCA function (Bates et al., 2015). See the package RePsychLing (<https://github.com/dmbates/RePsychLing>) for examples and more theoretical background.

The rePCA function computes a principal components analysis of the variance covariance matrices for the random effects (subject and item), which allows the modeler to decide which variance components should be included. No attempt was made to fit correlations between intercepts and slopes, for subjects or for items.

In the second analysis, we fitted Bayesian hierarchical (so-called linear mixed) models using Stan. Again, sum contrasts were used to code main effects and interactions. In addition, a nested contrast was defined for a secondary analysis in order to look at the effect of distance in complex predicates versus the control conditions separately; these were also coded as sum contrasts. We fit full variance-covariance matrices for participants and items (the so-called maximal model, Barr et al., 2013; Bates et al., 2015).

3.2.2. Results

3.2.2.1. Response accuracy

Participants answered correctly on average 92.73 percent of the comprehension questions (excluding fillers). Accuracy was 91, 94, 95 and 91 percent respectively for the four conditions in (1). A generalized linear mixed

model of the binary responses showed an interaction (coef=-0.25, SE=0.10, $z = -2.37$) between predictability and distance. A nested contrast suggests that this interaction is driven by the weak predictability condition, such that response accuracy is lower in the long condition compared to the short condition.

Table 3.2. Means, 95% uncertainty intervals, and $P(b < 0)$, the probability of the estimate being less than 0, in the question-response accuracy analysis for the first self-paced reading experiment looking for the effects of distance and predictability

Comparison	Mean	Lower	Upper	$P(b < 0)$
Intercept	3.3271	2.8738	3.8724	0
Distance	0.033	-0.3242	0.4033	0.4212
Predictability	-0.174	-0.6128	0.2239	0.8002
Distance x Predictability	0.158	-0.1147	0.4385	0.1345

3.2.2.2. Reading time

Reading times (RTs) were analyzed at the verb. As shown in **Table 3.3** and **Figure 3.1**, there was a main effect of distance ($t=3.88$), such that increasing distance led to longer reading times. There was also a main effect of predictability ($t=-2.94$): the complex predicate conditions were read faster overall as compared to simple predicate conditions. A marginal interaction ($t=1.70$) is also seen: stronger locality effects are seen in the simple predicate condition (control condition) than in the complex predicate condition.

Table 3.3. Coefficients, standard errors, and t-values for the main effects and interactions in the first self-paced reading experiment looking for the effects of distance and predictability

Comparison	Coefficient	SE	t-value
(Intercept)	6.24	0.04	151.99
Distance	0.04	0.01	3.88
Predictability	-0.03	0.01	-2.94
Distance x Predictability	0.02	0.01	1.70

According to the Bayesian analysis (**table 3.4**), there was a main effect of distance, such that increasing distance led to longer reading times. There was also a main effect of predictability: the complex predicate conditions were read faster overall. A weak interaction was also seen: stronger locality effects were seen in the control conditions than in the complex predicate conditions. A nested analysis also shows that the distance effect was caused by the control (weak predictability) condition.

Table 3.4. Means, 95% uncertainty intervals, and $P(b < 0)$, the probability of the estimate being less than 0, in the reading time analysis for the first self-paced reading experiment looking for the effects of distance and predictability

Comparison	Mean	Lower	Upper	$P(b < 0)$
Intercept	6.2434	6.1644	6.3226	0
Distance	0.0397	0.0174	0.0619	2e-04
Predictability	-0.0328	-0.0566	-0.0096	0.998
Distance x Predictability	-0.0179	-0.0405	0.0046	0.942

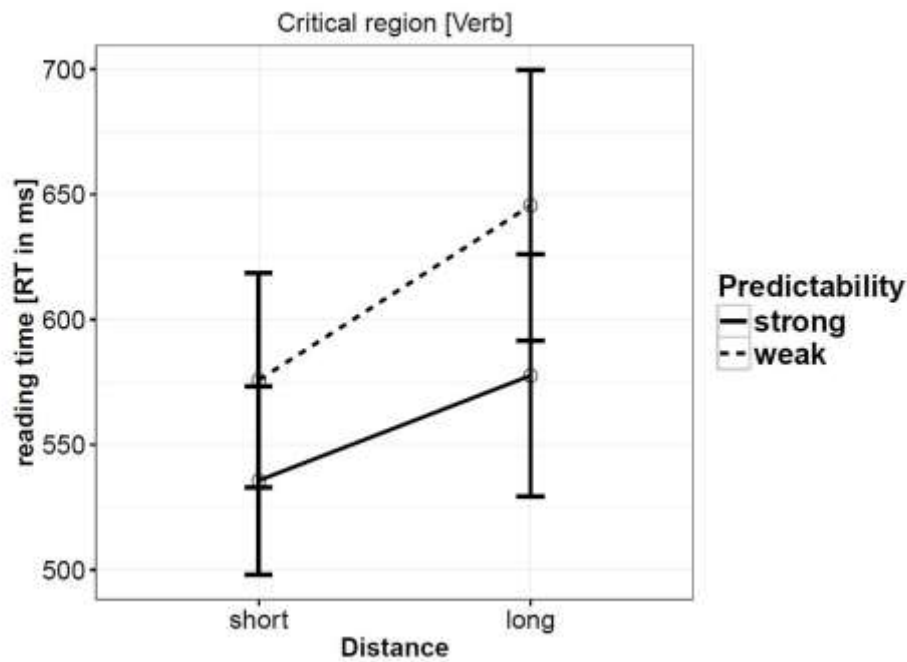


Figure 3.1 | Reading times at the critical verb in the first self-paced reading experiment looking for the effects of distance and predictability

3.2.3. Discussion

Experiment 1 found a main effect of predictability such that the verbs in the strong predictability conditions were read faster than the weak predictability conditions, and a main effect of distance, such that the verbs in the short conditions were read faster than the long conditions. A nested contrast showed that this effect of distance was driven by the weak predictability conditions, i.e., within the weak predictability conditions, the reading times at the position of the verb in the short condition were faster than the reading times in long condition. A weak interaction suggests that the locality effect may be somewhat stronger in the weak predictability condition. A marginal effect of interaction between predictability and distance seems to provide only weak support, if any, for the idea that strong predictability can at least attenuate locality effects (Husain et al., 2014).

The overall effect of distance is consistent with memory-based accounts, which correctly predict a slowdown at the verb in the long conditions, i.e., a main effect of distance. However, as the nested comparison shows, the main effect of distance is driven only by the weak predictability (non-complex predicate) conditions. Memory-based theories are unable to explain this because they predict a slowdown in long conditions irrespective of predictability strength. Nevertheless, note that the absence of an interaction makes this absence of a distance effect in the strong predictability conditions difficult to interpret.

The expectation account's prediction regarding distance, that increasing the argument-verb distance has either no effect or results in a facilitation, was clearly not validated. However, the main effect of predictability is consistent with a version of the expectation account that uses the conditional probability of the exact lexical item (verb) appearing given the preceding context.

Our original motivation for this study was to replicate the Husain et al. (2014) findings for Persian. The results are not inconsistent with those of Husain et al. (2014), but they are also not a strong validation of the memory and expectation interaction posited in that paper. As in the Husain et al. (2014) study, we see a main effect of predictability driven by the complex predicate condition. This effect can be explained in terms of reduced retrieval cost at the verb due to its high expectation.

An obvious confounding factor here is that the verbs in the strong vs weak predictability conditions are not identical; this prevents us from ruling out the possibility that low-level differences in the verbs are responsible for the facilitation due to prediction strength.

We speculate that one reason why we see this trend towards locality in spite of the strong expectation has to do with the nature of the intervener. Unlike

Husain et al. (2014), where the long distance condition had extra adverbials compared to the short condition, in Experiment 1 we have a more complex intervener, a relative clause. Although both Vasishth and Drenhaus (2011) and Levy and Keller (2013) argue that memory load is critical for having either locality or anti-locality effect, none of them investigate the role of memory load on maintaining prediction. We reasoned that if a prediction has to be actively maintained in working memory, it will take up resources. As a result, since working memory is limited, processing different levels of syntactic complexity (while maintaining a prediction at the same time) may have a negative impact on the trace of the predicted chunk in memory. Therefore, manipulating the complexity of the intervening material may provide a better test of the interaction between memory decay and expectation.

In order to determine whether the locality effect depends on the nature and complexity of the intervener, we also ran an experiment in which a short versus a long prepositional phrase was the intervener. We had no theoretical basis for deciding whether a prepositional phrase intervener is more or less complex than a relative clause intervener; at a minimum, our next experiment, reported below, tests whether the nature of the intervener affects whether we see locality effects in this argument-verb configuration.

Therefore, we designed experiment 2, in which we manipulate the type of intervener. Here, in the long distance condition, instead of a relative clause and prepositional phrase intervener, a long prepositional phrase intervenes. The motivation was to increase distance without having different types of interveners in the short vs long conditions, as is be a better comparison.

3.3. Locality and expectation in Persian: evidence from self-paced reading

In the following sections, the second self-paced reading study will be presented. The manipulation of this experiment, unlike the previous experiment, only involves a prepositional phrase (short versus long) as the intervening phrases used to separate the complex predicates.

3.3.1. Methodology

3.3.1.1. Participants

In this experiment, forty-three adults with the same criteria as in the first self-paced reading study participated. They were all between 17 and 40 years old (with mean of 24 years old). They were from Tehran (Iran) and native speakers of Persian. They all had normal or corrected-to-normal eye-sight with no known history of neurophysiological and cognitive disorders. We made sure that the participants were unaware of the purpose of the study which was conducted in accordance with Helsinki Declaration. Letters of consent were obtained from all of the participants. The participants were different from the ones who took part in the previous study.

3.3.1.2. Materials

Similar to the first self-paced reading study, the materials consisted of 36 sets of items with a 2x2 factorial design. Therefore, in the whole experiment we had 144 sentences which were latin-squared across the four conditions such that the participants only saw one condition of each item ID.

In our design, the two factors of predictability strength and distance were manipulated. As for the first factor, the manipulation was done between the noun (either the nominal of the complex predicate in conditions ‘a’ and ‘b’ or

the direct object of the simple predicate conditions in ‘c’ and ‘d’) and its verb (light verb in the complex predicate conditions and heavy verb in the simple predicate conditions) such that the light verbs are highly predictable and the heavy verbs are highly unpredictable. This predictability was judged in the first pre-test which was discussed in chapter 2. Regarding distance manipulation, an intervener was inserted between the noun and its verb such that conditions ‘a’ and ‘c’ with a short prepositional phrase as the intervening material are shorter compared to conditions ‘b’ and ‘d’ which had a longer prepositional phrase as the intervener without any relative clause as in the first self-paced reading study. In this way we have more comparable conditions by keeping the nature of the intervener the same.

As mentioned in the section related to the first self paced reading task, we masked the stimuli by including 100 fillers with different syntactic structures, so that the participants could not recognize our designed pattern. Below an example for each condition is given. It is worth mentioning that the critical region was the light verb (in this example ‘kard’) versus the heavy verb (in this example ‘xarid’). The main experimental sentence was always continued by a coordinate structure, so that the critical region would not fall at the end of the sentence.

The stimuli and fillers were the same as in experiment 1 except for the long conditions (b and d), where the intervener was a longer prepositional phrase instead of the combination of a relative clause and a prepositional phrase as in the previous experiment. The prepositional phrase was lengthened using several different structures as the following, all of which had one or more instance of the so-called Persian ‘ezafe’ marker (marked as ‘ez’ in the following examples), connecting the nouns and/or adjectives to one another (Samvelian, 2007). In Persian, Ezafe is a short vowel /-e/ (or sometimes /-ye/ when it is followed by a vowel) which is unstressed and applied to link two

words in some contexts (e.g., to mark possession). This vowel is often not written but automatically considered and pronounced by the native speakers of Persian.

1. Noun-ez + noun-ez + noun/pronoun/proper name
2. Noun-ez + adjective-ez + noun/pronoun/proper name
3. Noun-ez + adjective-ez + noun
4. Noun-ez + noun-ez + adjective
5. Noun + adjective-ez + adjective
6. Superlative adjective + noun + noun/pronoun/proper name
7. Noun-ez + pronoun

One set of examples using the first type of prepositional phrase shown above is as follows:

a. Short distance + strong predictability of the head

Ali a:rezouyee bara:ye man (kard)...
 Ali wish-INDEF for 1.S (do-PST) ...
 ‘Ali (made) a wish for me...’

b. Long distance + strong predictability of the head

Ali a:rezouyee bara:ye doost-e xa:har-e man (kard)...
 Ali wish-INDEF for friend-EZ sister-EZ 1.S (do-PST) ...
 ‘Ali (made) a wish for my sister’s friend...’

c. Short distance + weak predictability of the head

Ali shokola:ti bara:ye man (xarid)...
 Ali chocolate-INDEF for 1.S (buy-PST) ...
 ‘Ali (bought) a chocolate for me...’

d. Long distance + weak predictability of the head

Ali shokola:ti bara:ye doost-e xa:har-e
 Ali chocolate-INDEF for friend-EZ sister-EZ
man (xarid)...
 1.S (buy-PST) ...
 ‘Ali (bought) a chocolate for my sister’s friend...’

All experimental sentences as well as the fillers were followed by a true-false comprehension-check questions which targeted different thematic roles in the sentence. The distribution of these sentences was such that half of them were false and the other half was true. All the materials can be found in the appendices.

3.3.1.3. Procedure

As mentioned in the first self-paced reading study, the individuals were tested in a silent room in front of a PC. They were explained the procedure of the experiment thoroughly and instructed to read the sentences that appeared on the screen at a normal pace and answer the comprehension-check questions that followed them. Also, they were shown a set of 5 practice items before the actual experiment started.

The stimuli were presented on a single line with the font of 22 pt Persian Arial on Linger software (<http://tedlab.mit.edu/~dr/linger/>) with a ‘moving window’ paradigm in which the participants had to read the sentences word by word successively as they pressed the space button on the keyboard. So the previous word was masked and the new word appeared on the screen. After all of the sentences, a true-false comprehension check question appeared which the participants had to answer based on the sentence they read before by pressing the two previously-specified buttons. These questions targeted different parts of the sentence (in terms of the content) to ensure that the participants paid attention to the complete sentence. The whole experiment took on average 30 minutes for each individual.

3.3.1.4. Statistical analysis

As in the first self-paced reading study, the data were analyzed in R environment with two different statistical methods of linear-mixed models (rePCA) and Bayesian analysis using Stan. For more information, refer to the statistical analysis section of the previous experiment, that is, section 3.2.1.4.

3.3.2. Results

3.3.2.1. Response accuracy

Participants answered 93% of all comprehension questions correctly on average (excluding fillers). The accuracies by condition were 96, 92, 94, and 89% percent respectively for the four conditions in (2). As shown in **Table 3.5**, the Bayesian generalized linear mixed models of the responses showed a main effect of distance, such that accuracies were lower in the long conditions. No effect of predictability strength, and no interaction between predictability strength and distance were found.

Table 3.5. Means, 95% uncertainty intervals, and $P(b < 0)$, the probability of the estimate being less than 0, in the question-response accuracy analysis for the second self-paced reading experiment looking for the effects of distance and predictability

Comparison	Mean	Lower	Upper	$P(b < 0)$
Intercept	3.1092	2.7277	3.5353	0
Distance	-0.4246	-0.7556	-0.133	0.9972
Predictability	0.1798	-0.1871	0.5605	0.157
Distance x Predictability	-0.0742	-0.3478	0.1832	0.7098

3.3.2.2. Reading time

As shown in **Table 3.6** and **Figure 3.2**, the results showed a main effect of distance ($t=3.99$), with the verbs in long distance conditions being retrieved slower. There was also an effect of predictability ($t=-2.28$), with the verbs in the strong predictability condition being read faster than the weak predictability condition. No interaction was found between predictability and distance.

Table 3.6. Coefficients, standard errors, and t-values for the main effects and interactions in the second self-paced reading experiment looking for the effects of distance and predictability

Comparison	Coefficient	SE	t-value
Intercept	6.27	0.04	147.86
Distance	0.06	0.01	3.99
Predictability	-0.02	0.01	-2.28
Distance x Predictability	-0.01	0.01	-0.67

The results of the Bayesian analysis (as seen in **table 3.7**) showed a main effect of distance, with long distance conditions being read slower. There was only a weak effect of predictability, with the strong predictability condition being read faster than the weak predictability condition. No interaction was found between predictability and distance. The effect of distance was present in both strong and weak predictability conditions.

Table 3.7. Means, 95% uncertainty intervals, and $P(b < 0)$, the probability of the estimate being less than 0, in the reading time analysis for the second self-paced reading experiment looking for the effects of distance and predictability

Comparison	Mean	Lower	Upper	$P(b < 0)$
Intercept	6.2676	6.1867	6.3488	0
Distance	0.0547	0.0269	0.0827	0
Predictability	-0.0203	-0.0417	0.0013	0.966
Distance $\times$ Predictability	0.0077	-0.016	0.0318	0.2585

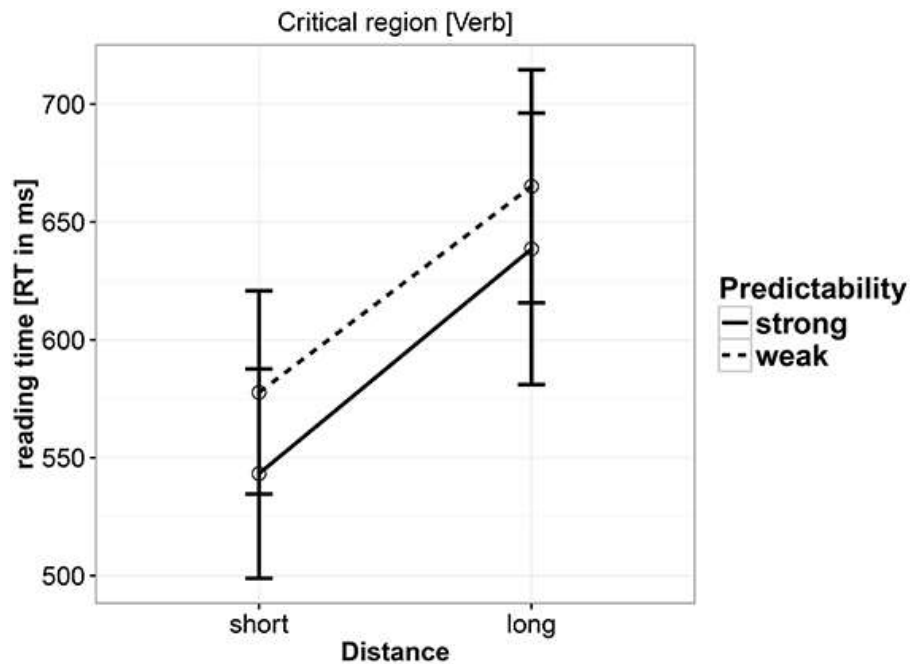


Figure 3.2. Reading times at the critical verb in the second self-paced reading experiment looking for the effects of distance and predictability

3.3.3. Comparison of the two self-paced reading studies

A secondary analysis was conducted to compare the strength of the locality effect in the two experiments, and to determine whether an interaction between distance, predictability and experiment was present. The between-participant factor experiment was coded using sum coding: experiment 1 was coded -1, and experiment 2 was coded +1. The results (as shown in **Table 3.8**) from the linear mixed model indicate a main effect of distance such that the locality effects are stronger in experiment 2 as compared to experiment 1. However, the Bayesian model (as shown in **Table 3.9**) does not provide a convincing evidence for an interaction between distance and experiment; there

is only weak evidence for a larger effect of distance in experiment 2. Therefore, we cannot argue for a qualitative difference in the distance effects found in the two experiments.

Table 3.8. Coefficients, standard errors, and t-values for the main effects and interactions in the combined analysis of the two self-paced reading experiments

Comparison	Coef.	SE	t-value
Intercept	6.23	0.03	231.29
Distance	0.03	0.01	3.72
Predictability	-0.02	0.01	-2.25
Expt	0.04	0.03	1.67
Distance×Predictability	-0.00	0.01	-0.55
Distance× Expt	0.03	0.01	5.58
Predictability× Expt	-0.01	0.01	-1.27
Pred× Dist × Expt	0.01	0.01	1.66

Table 3.9. 95% uncertainty intervals, and $P(b < 0)$, the probability of the estimate being less than 0, in the reading time analysis for the combined analysis of the two self-paced reading experiments

	mean	lower	upper	$P(b_i < 0)$
Intercept	6.2578	6.1974	6.3198	0
Distance	0.0475	0.0307	0.0647	0
Predictability	-0.0266	-0.0442	-0.0078	0.9958
Expt	0.0138	-0.0425	0.0653	0.299
Distance×Predictability	-0.0054	-0.0203	0.0101	0.761
Distance× Expt	0.0073	-0.0075	0.0219	0.1558
Predictability× Expt	0.0063	-0.0069	0.0193	0.171
Pred× Dist × Expt	0.0128	-0.0012	0.0264	0.0357

3.3.4. Discussion

In this experiment, we replicated the locality effects found in experiment 1, but we no longer see a weakening of the locality effect that was seen in experiment 1 (a marginal interaction between the distance and predictability in experiment 1 such that the locality effects might get weakened as a result of strong predictability). The strength of locality effects was equal in the strong and weak predictability conditions.

In experiment 2, we also see an effect of predictability, with the strong predictable verb being read faster. Regarding the distance manipulation, the working-memory account's prediction is validated, and the expectation-based account's prediction is not supported. The main effect of predictability does furnish evidence consistent with the expectation-based account.

In the second self-paced reading experiment, the intervener was a long uninterrupted prepositional phrase whereas in experiment 1, the intervener consisted of a short relative clause followed by a prepositional phrase. One can speculate as to why experiment 2 shows equally strong distance effects in both predictability conditions: processing a single long intervening phrase may be harder than processing two different phrases because it may be harder to chunk a single long phrase compared to two shorter phrases; this is predicted by the Sausage Machine proposal of Frazier and Fodor (1978). If this is correct, then the complexity of the intervener may indeed be a relevant factor in determining whether strong expectation can weaken locality effects. It is possible to test this claim by using an intervener that is easier to process; an example is an adverb containing no noun phrases.

3.4. General discussion

Our main finding is that the Levy's account of expectation-based facilitation (2008) is not supported by the Persian data; rather, our results are in favor of dependency distance accounts (Gibson, 2000). This result is quite problematic for the expectation view and suggests a closer examination of the claims of expectation theory.

In previous work, Husain et al. (2014) and Jäger et al. (2015) have successfully validated the principles of expectation-based account by using sentence completion data . This is the approach that we took for the present experiments. Given that we have been able to demonstrate a correspondence between expectations as computed using sentence completions and online reading data, it is reasonable to assume that despite the increased expectation of the upcoming verb, at least in our Persian data, it is integration cost that dominates.

The experiments presented here also provide suggestive (but weak) evidence that the complexity of intervening material could be critical for prediction maintenance: when the intervener is a relative clause followed by a prepositional phrase, we see a marginal interaction between distance and expectation, but when the intervener is a single long prepositional phrase, we see no evidence for an interaction between distance and expectation strength.

As always, it is vital to attempt to replicate the results to establish robustness. In the next studies, we will examine these effects using another methodology: eye-tracking.

Chapter four

Long-distance dependency resolution in Persian: evidence from eye-tracking studies on separable complex predicates

4.1. Introduction

In the sentence comprehension literature, it is well-known that processing costs increase with dependency distance (Gibson, 2000; Lewis and Vasishth, 2005); this is often referred to as locality effects. However, the expectation-based account (Hale, 2001; Levy, 2008) predicts that delaying the appearance of a verb renders it more predictable and therefore easier to process. So, we investigated whether strengthening the expectation can increase facilitation at the verb. We used Persian for this study. This language has a special construction called ‘complex predicate’, which is a separable noun-verb configurations in which the verb (the precise lexical item) is highly predictable given the noun.

While works such as Staub (2010), Vasishth and Drenhaus (2011) demonstrate that working memory constraints and predictive processing interact, it is far from clear under what conditions this happens. The experiments discussed in the current chapter investigate this interaction. In particular, we ask the following questions:

- (1) What is the effect of strong versus weak expectation strength on processing at the head?
- (2) What is the effect of the type of the intervening phrases on processing the head?

The first question is motivated by the study of Husain et al. (2014) and like them we will also use complex predicates (this time in Persian) in order to manipulate expectation strength. The notion of strong versus weak expectation, in our opinion, has the desirable property of controlling the effect of predictability such that it is experimentally measurable (through, for example, a sentence completion task).

More importantly, rather than using a continuous notion of predictability where any resulting behavioral difference might be subtle, strong versus weak expectation makes the predictability manipulation discreet, thereby possibly increasing the chance of seeing a significant effect due to expectation, if any. Although both Vasishth and Drenhaus (2011) and Levy and Keller (2013) argue that memory load is critical for having a locality or expectation effect.

The second question is motivated by the idea that if a prediction has to be actively maintained in working memory, it will take up resource and since working memory capacity is limited, processing at different levels of syntactic complexity while simultaneously maintaining a prediction may have a negative impact on the trace of the predicted chunk in memory. So,

manipulating the complexity of the intervening material provides a better manipulation to study the interaction between memory decay and expectation.

This chapter concerns the two eye-tracking studies in which we attempted to replicate the ‘results’ of the two self-paced reading studies, discussed in chapter 3.⁹ Furthermore, eye-tracking method can be very informative because it not only provides us with data about the gaze proportion and reading time but also about the regressions made while reading the sentences. Also, it is possible that self-paced reading overburdens the working-memory system in an unnatural manner (by masking the previous word once the new word appears). If this is the case, one prediction is that the eye-tracking data do not necessarily show locality effects.

It should be noted that despite a wide range of eye-tracking studies in sentence processing literature (Clifton et al., 2007; Boston et al., 2008, 2011), it is still unclear what measures reflect the effects of syntactic processing. One can generally categorize these measures to three types: (i) first-pass events; (ii) regression-related events (proportion and duration of eye gaze); and (iii) second-and later pass events (Jäger et al., 2015). In our experiments, we report the First Pass Reading Time (also, gaze duration) as well as Regression-Path Duration as the two key measures that play a critical role in answering our research questions.

4.2. Locality and expectation in Persian I: evidence from eye-tracking

In this study, we used eye-tracking method to investigate the locality and expectation effects in Persian complex predicates. To this aim, the two factors of distance (short versus long) and predictability (strong versus weak) were

⁹ This replication attempt was also motivated by the recent report of Open Science Collaboration (2015) on the replication crisis in psychology.

interposed across conditions to see whether manipulating the intervener between the parts of the complex predicate (which is considered a long distance dependency when separated) would lead to processing difficulty or facilitation at retrieving the verb.

4.2.1. Methodology

4.2.1.1. Participants

Forty participants were tested individually at the Golm Campus of University of Potsdam, Germany. There were all Iranian and native speakers of the Persian language who had been outside Iran for not more than two years. They had at least 12 years of education. None of them reported any history of neurophysiological or cognitive disorders, and all had normal or corrected-to-normal vision. Consent letters were obtained from the participants before the study and the study was conducted in accordance with Helsinki declaration.

4.2.1.2. Materials

The experimental items were the same as in the first self-paced reading experiment, except that the following four items from experiment 1 were removed: item id 5, sheka:yat kardan (complain + to do), item id 9, sahm bordan (share + to win), item id 26, pishraft kardan (progress + to do), and item id 32, hes kardan (feel + to do). The reason for removal was that the results of the sentence completion studies suggested that these light verbs had lower predictability than the other light verbs in the stimuli. It could be that this lower predictability is due to the existence of some alternative light verbs with which the nominal part can combine to make other possible complex predicates. The last two complex predicates also had a lower acceptability

rating (item 26 had 4.7, and item 32 had 3.5). As a consequence, in our eye-tracking study, we had thirty-two experimental items and sixty-four fillers. All items, including fillers are available in the appendices. A set of examples for different conditions of this experiment can be seen below.

a. Short distance + strong predictability of the head

Ali a:rezouyee bara:ye man (kard)...
 Ali wish-INDEF for 1.S (do-PST) ...
 ‘Ali (made) a wish for me...’

b. Long distance + strong predictability of the head

Ali a:rezouyee ke besya:r doost-da:asht-am
 Ali wish-INDEF that a lot like-1.S-PST
bara:ye man (kard)...
 for 1.S (do-PST) ...
 ‘Ali (made) a wish for me that I liked a lot. . .’

c. Short distance + weak predictability of the head

Ali shokola:ti bara:ye man (xarid)...
 Ali chocolate-INDEF for 1.S (buy-PST) ...
 ‘Ali (bought) a chocolate for me...’

d. Long distance + weak predictability of the head

Ali shokola:ti ke besya:r doost-da:sht-am
 Ali chocolate-INDEF that a lot like-1.S-PST
bara:ye man (xarid)...
 for 1.S (buy-PST) ...
 ‘Ali (bought) a chocolate for me that I liked a lot...’

4.2.1.3. Procedure

An eye-tracking study was prepared using Experiment-Builder software, and participants’ eye-movements were recorded using an EyeLink 1000 tracker, with a connection to a PC. Before the experiment started, the participants were instructed to read the sentences silently at a normal pace and had a practice block consisting of five sentences. After answering the comprehension

questions of the practice block, they were provided with feedback indicating whether or not the answer was correct. For example, for a sentence like *I ate what my mother had cooked*, the comprehension-check true/false question was *I ate what my wife had cooked*(in Persian).

A 21-inch monitor was placed 60 centimeters from the participants' eyes. In order to reduce head movements, the participants were asked to use the chin-rest. They viewed the sentences with both eyes, but only the right eye was recorded. The items were presented in one line (the whole sentence appeared at once) and in 18 points Persian Arial font (from right to left). First, they had to fixate on a dot at the right edge of the screen so that the sentence appeared. After they finished reading, they had to fixate on the dot in the bottom left corner of the screen; once they fixated on the dot, the comprehension question was presented. Unlike with the practice items, they were not provided with any feedback. Calibration was performed at the beginning of the experiment, after their 5-minute break (which occurred after they had were halfway through the experiment), and whenever it was necessary.

4.2.1.4. Statistical analysis

Raw gaze duration data were obtained using the Data Viewer software. These data were then processed to get different eye-tracking measures using the 'em2 package' (Logac̣ev and Vasishth, 2013). Bayesian linear mixed models were used for the analysis. All analyses were carried out using log-transformed data. Zero ms reading times were removed before carrying out the analysis.

4.2.2. Results

4.2.2.1. Response accuracy

On average, participants answered 92 percent of the target comprehension questions correctly. Mean accuracy by condition was 91 percent for condition a, 91 percent for condition b, 95 percent for condition c, and 89 percent for condition d. We found no effects of distance and predictability, and no interaction.

4.2.2.2. Eye-tracking measures

The critical region was the verb, as in the self-paced reading studies discussed in chapter 3. The same sum contrast coding was also used here. We present results for first-pass reading time and regression path duration.

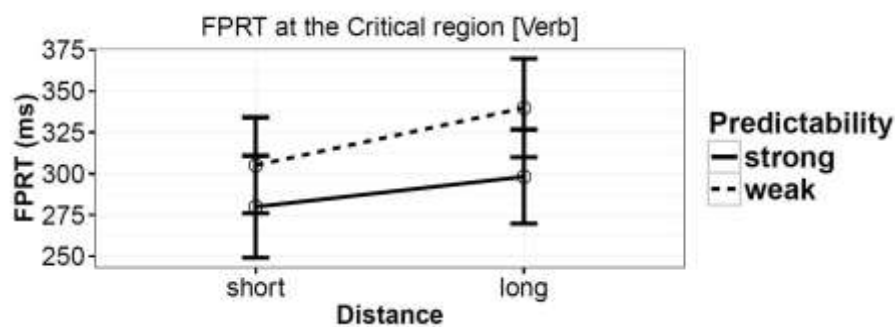


Figure 4.1. First-pass reading time (FPRT) at the critical verb in the first eye-tracking experiment looking for the effects of distance and predictability. Error bars show 95% confidence intervals.

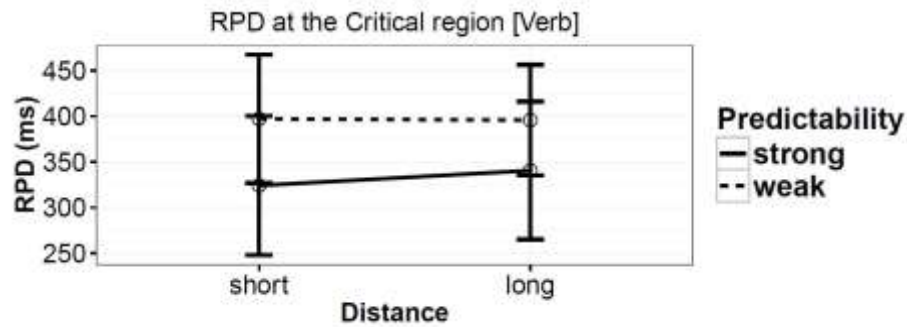


Figure 4.2. Regression Path Duration (RPD) at the critical verb in the first eye-tracking experiment looking for the effects of distance and predictability. Error bars show 95% confidence intervals.

As indicated in **Figure 4.1** and **Figure 4.2**, the effect of predictability, seen in the self-paced reading experiments, is also present in first-pass reading time ($t=-3.08$) and in regression path duration ($t=-3.21$); while the strong-predictability conditions had shorter reading times. Also, as in the studies in previous chapter, there was an effect of distance in first pass reading time ($t=2.67$); the long-distance conditions have longer reading times. **Table 4.1** shows the details of the analyses.

Table 4.1. Coefficients, standard errors, and t-values for the main effects and interactions in first-pass reading time (FPRT) and regression path duration (RPD) in the first eye-tracking experiments looking for the effects of distance and predictability

ET 1 measures	Comparison	Coef	SE	t value
Log FPRT	Intercept	5.62	0.03	175.88
	Distance	0.05	0.02	2.67
	Predictability	-0.053	0.02	-3.08
	Distance $\times$ Predictability	0.01	0.01	0.79
Log RPD	Intercept	5.73	0.04	128.98
	Distance	0.04	0.02	1.47
	Predictability	-0.08	0.02	-3.21
	Distance $\times$ Predictability	0.004	0.02	0.26

In the Bayesian analysis, sum contrast coding was used as in the self-paced reading experiments. We present results for first-pass reading time and regression path duration.

The effect of predictability, seen in the self-paced reading studies, is also present in first-pass reading time and regression path duration; the strong-predictability conditions had shorter reading times. There was also an effect of distance in first-pass reading time but only a weak effect in regression path duration; the long-distance conditions had longer reading times. **Table 4.2** shows the details of the analyses.

Table 4.2. Means, 95% uncertainty intervals, and $P(b < 0)$, the probability of the estimate being less than 0, in the first-pass reading time (FPRT) and regression path duration (RPD) for the first eye-tracking experiment looking for the effects of distance and predictability

ET measure	Comparison	Mean	Lower	Upper	$P(b < 0)$
FPRT	Intercept	5.623	5.5627	5.6833	0
	Distance	0.0504	0.0123	0.0868	0.0062
	Predictability	-0.0522	-0.0844	-0.0189	0.9968
	Distance × Predictability	-0.01	-0.039	0.0196	0.7455
RPD	Intercept	5.7286	5.646	5.8105	0
	Distance	0.0331	-0.0139	0.0814	0.074
	Predictability	-0.0754	-0.1248	-0.0265	0.9992
	Distance × Predictability	-0.0032	-0.0374	0.0316	0.5742

4.2.3. Discussion

In this eye-tracking study, we replicated the locality effects found in the reading time of self-paced reading studies. These locality effect appeared in weak-predictability conditions, which is similar to the result in the first self-paced reading as discussed in chapter 3. A main effect of predictability was found in first-pass reading time and regression path duration, replicating the effect in self-paced reading 1. Since we failed to find an interaction between predictability and distance, we cannot conclude, as Husain et al. (2014) did, that expectation effects can cancel out locality effects.

The locality effects are consistent with working memory accounts (Gibson, 2000; Lewis and Vasishth, 2005) and inconsistent with the distance-based predictions of the expectation account (Levy, 2008). As in the self-paced reading experiments, we have evidence consistent with a version of the expectation account that predicts that strong predictability conditions are read faster than the weak predictability conditions. In sum, the main result of the first eye-tracking study is that we have replicated the locality effect and the facilitation due to strong predictability with a different methodology.

4.3. Locality and expectation in Persian II: evidence from eye-tracking

In the following sections, the second eye-tracking study will be described which aims at investigating locality or expectation effects in separable Persian complex predicates by manipulating the conditions with the two factors of distance and predictability similar to the second self-paced reading study discussed in chapter 3. We will explain the design and experimental items in the materials section in details. The main motivation for conducting such a comparative study was that self-paced reading may add higher load to working memory as the stimulus is shown word by word which is in contrary to the

way our brain is used to. So, eye-tracking can be a more informative method for the natural process of reading, while providing more information about the proportion of eye gaze and regressions. As a result, we might not see the locality effects found in the similar self-paced reading study.

4.3.1. Methodology

4.3.1.1. Participants

Forty individuals (different from the previous group) participated in the study which was conducted at the Golm Campus, University of Potsdam, Germany. They were all Iranian, native speakers of Persian, with no report of physiological or mental disorders, with minimum 12 years of education, and normal or corrected-to-normal eye-sight. The guidelines of the study were in accordance with the declaration of Helsinki and the participants signed consent letter before they actually started the experiment.

4.3.1.2. Materials

The experimental items were the same as in the second self-paced reading experiment, but with 32 items (see the explanation for the first eye-tracking experiment above regarding the four items that were removed). The experimental items were complemented with 64 filler sentences with varying syntactic structures. A set of examples for the four conditions can be seen below.

a. Short distance + strong predictability of the head

Ali a:rezouyee bara:ye man (kard)...

Ali wish-INDEF for 1.S (do-PST)...

‘Ali (made) a wish for me...’

b. Long distance + strong predictability of the head

Ali a:rezouyee bara:ye doost-e xa:har-e man (kard)...
Ali wish-INDEF for friend-EZ sister-EZ 1.S (do-PST)...
'Ali (made) a wish for my sister's friend...'

c. Short distance + weak predictability of the head

Ali shokola:ti bara:ye man (xarid)...
Ali chocolate-INDEF for 1.S (buy-PST)...
'Ali (bought) a chocolate for me...'

d. Long distance + weak predictability of the head

Ali shokola:ti bara:ye doost-e xa:har-e
Ali chocolate-INDEF for friend-EZ sister-EZ
man (xarid)...
1.S (buy-PST)...
'Ali (bought) a chocolate for my sister's friend...'

4.3.1.3. Procedure

The procedure was the same as the first eye-tracking experiment.

4.3.1.4. Statistical analysis

The statistical analysis was the same as the first eye-tracking experiment.

4.3.2. Results

4.3.2.1. Response accuracy

On average, participants answered 90 percent of comprehension questions correctly. They had 94 percent response accuracy for condition a, 88 percent for condition b, 94 percent for condition c, and 86 percent for condition d. None of the factors had an effect on accuracy.

4.3.2.2. Eye-tracking measures

Unlike the first eye-tracking study, in the second experiment, we found effects of distance ($t=2.46$ and $t=3.63$) and predictability ($t=05.10$ and $t=4.76$) in both measures of first-pass reading time and regression path duration (see **Figure 4.3** and **Figure 4.4**). In other words, the long conditions (b and d) were read slower than the short conditions (a and c), and the weak predictability conditions (c and d) were read slower than the strong predictability conditions (a and b). None of the measures showed an interaction between predictability and distance (see **Table 4.3**).

Table 4.3. Coefficients, standard errors, and t-values for the main effects and interactions in the second eye-tracking experiment looking for the effects of distance and predictability

ET measures	Comparison	Coef	SE	t value
Log FPRT	Intercept	5.67	0.04	147.60
	Distance	0.06	0.02	2.46
	Predictability	-0.11	0.02	-5.10
	Distance $\times$ Predictability	-0.01	0.02	-0.30
Log RPD	Intercept	5.79	0.05	125.45
	Distance	0.08	0.02	3.63
	Predictability	-0.11	0.02	-4.76
	Distance $\times$ Predictability	0.01	0.02	0.43

Based on the Bayesian analysis, we also found effects of distance and predictability in both the measures (see **Table 4.4**). In other words, in the two measures reported, the long conditions (b and d) were read slower than the short conditions (a and c), and the weak predictability conditions (c and d) were read slower than the strong predictability conditions (a and b). None of the measures showed any interaction between predictability and distance.

Therefore, the results of the Bayesian modeling are the same the linear mixed model explained above.

Table 4.4. Means, 95% uncertainty intervals, and $P(b < 0)$, the probability of the estimate being less than 0, in the reading time analysis for the second eye-tracking experiment looking for the effects of distance and predictability

ET measure	Comparison	Mean	Lower	Upper	$P(b < 0)$
FPRT	Intercept	5.6731	5.6015	5.7448	0
	Distance	0.0557	0.0099	0.1013	0.0082
	Predictability	-0.1079	-0.1512	-0.0638	1
	Distance x Predictability	-0.0046	-0.0397	0.0315	0.6088
RPD	Intercept	5.7958	5.7113	5.8799	0
	Distance	0.0767	0.0316	0.1225	5e-04
	Predictability	-0.1108	-0.1588	-0.0626	1
	Distance x Predictability	0.0089	-0.0381	0.0547	0.3452

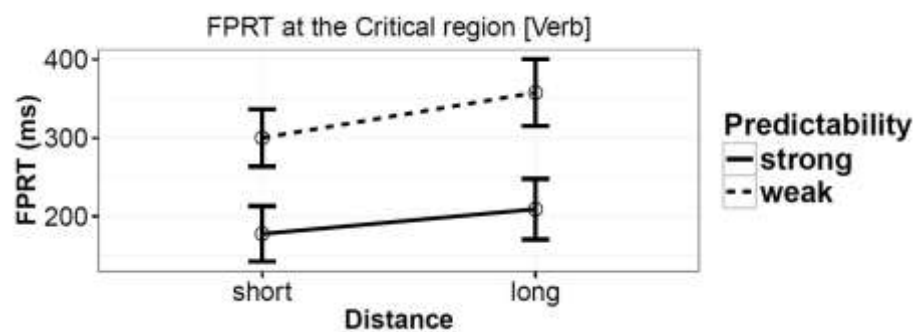


Figure 4.3. First-pass reading time at the critical verb in the second eye-tracking experiment looking for the effects of distance and predictability. Error bars show 95% confidence intervals.

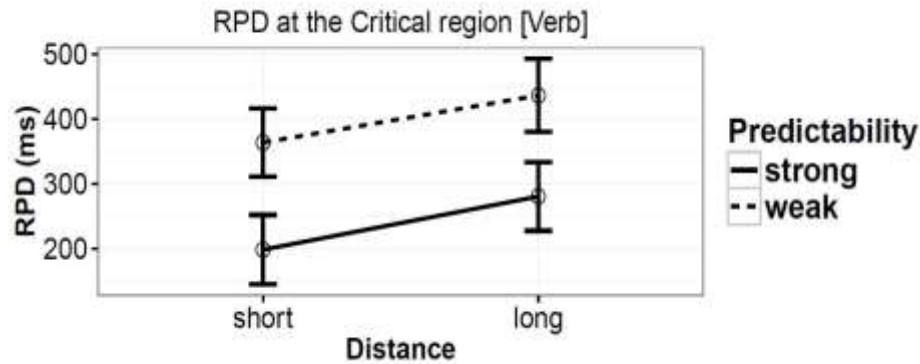


Figure 4.4. Regression path duration at the critical verb in the second eye-tracking experiment looking for the effects of distance and predictability. Error bars show 95% confidence intervals.

4.3.3. Discussion

The second eye-tracking experiment replicated the results of the second self-paced reading experiment: there was a main effect of distance and a main effect of predictability, with no evidence for an interaction. The effects in first-pass reading time and regression path duration showed essentially the same patterns as in the first eye-tracking study. However, the locality effects were even stronger, in the same way that the second self-paced reading study showed stronger locality effects. Also, these effects are equally strong in both the strong and weak predictability conditions, confirms our finding in the second self-paced reading study.

Overall, regarding the distance manipulation, the results are consistent with memory-based accounts, and inconsistent with the expectation account. The main effect of predictability is consistent with the expectation account, as discussed earlier. In the second eye-tracking study, we do not see any evidence consistent with the Husain et al. (2014) proposal; if anything, the locality effect is stronger in the strong-predictability conditions.

4.4. General discussion

In these two eye-tracking studies, which had similar experimental design and items to the self-paced reading studies presented in the chapter 3, we tried to have a more in-depth view of how a long-distance dependency such as Persian separable complex predicates can be resolved and to what extent our memory and expectation can affect this process. As our sentences were presented word-by-word in the self-paced reading experiment, we think that there might have been an unnecessary load on the participants' working memory that caused more difficulty in retrieving the light verb as a function of increased distance from its dependent noun, i.e., locality effects. Therefore, we used eye-tracking as a method that represents a more natural way of reading (by showing the sentence at once) and gives us more detailed information about the eye gaze. If the locality effects seen in self-paced reading experiments were due to the memory overload, we would expect a different result in eye-tracking studies. However, the results were interestingly quite similar to the previous ones.

Our results were in line with the key prediction of memory-based accounts, specifically Dependency Locality Theory (Gibson, 2000), in which a slow-down was expected due to increased distance between the parts of the complex predicate. There was a significant effect of distance in the first-pass reading time of the first eye-tracking study in which both relative clause and prepositional phrase formed the intervener of the long conditions. This effect was the same in the second eye-tracking study in both first-pass reading time and regression path duration. So, in both experiment, the effects of locality in favor of memory-based account were clearly seen. This finding was in contrary to the first prediction of the expectation-based account (Levy, 2008) in which a speed-up is predicted as a function of increased distance. However, the memory-based accounts do not take into account the level of predictability of the head which is a main factor considered in expectation-based accounts.

In this respect, a prediction of the expectation-based account was upheld as we consistently found a main effect of predictability in both first-pass reading time and regression path duration measure of both eye-tracking studies. In other words, the strong predictability conditions (i.e., complex predicates) were read faster than weak predictability conditions (i.e., simple predicates) across all conditions. As we found no effect of interaction between distance and predictability, we have no compelling evidence that high expectations (of the verb) can cancel the locality effects, as argued by Husain and colleagues (2016). Also, Levy's (2008) prediction that verb-final languages exhibit the patterns of memory-based accounts was not validated in our Persian data.

Chapter five

Discussion and Conclusion

5.1. Motivation for the current dissertation

Delaying the appearance of a verb in a noun-verb dependency distance tends to increase processing difficulty at the position of verb; one explanation for this so-called locality effect is decay and/or interference of the noun in working memory (Gibson, 2000; Lewis and Vasishth, 2005). Interestingly, Surprisal, which is an expectation-based account (Hale, 2001; Levy, 2008), makes the opposite prediction, that delaying the appearance of a verb renders it more predictable and therefore easier to process.

In this dissertation, the aim was to investigate whether a memory-based account or an expectation-based account, as the two prominent lines of

theories on long-distance dependency resolution, holds in Persian which is a relatively free-word-order SOV language.

To this purpose, a set of 4 psycholinguistic experiments (2 masked self-paced reading studies and 2 eye-tracking studies) were conducted in 4 different homogenous groups of native Persian speakers. Before these experiments, the stimuli (i.e., the experimental sentences) were validated by sentence-completion, acceptability rating and corpus studies. In our experimental design, we opposed complex predicate conditions to simple predicate conditions and manipulated the stimuli by two factors of distance (i.e., short conditions versus long conditions) and predictability (i.e., strong predictability versus weak predictability).

In the first self-paced reading study (as well as the first eye-tracking study which was meant to replicate the results of the self-paced reading study), the intervening materials consisted of a short prepositional phrase in the short conditions and a combination of a prepositional phrase and a relative clause in the long conditions. The aim was to find out whether delaying the appearance of the light verb/ heavy verb causes processing difficulty at the verb or has a facilitatory effect on processing.

In the second self-paced reading study (as well as the second eye-tracking study), the intervener did not include a relative clause, rather it only consisted of a short versus long prepositional phrase across the conditions. The motivation for the second experiment was to see whether processing different levels of syntactic complexity (two types of syntactic structures in the intervener versus only one type of syntactic structure as the intervener) may have an impact on prediction maintenance, considering the limitations of working memory. Also, we wanted to have a more controlled design. So, the aim of these studies was to find out whether or not having the same nature of intervener facilitates processing at the verb compared to the first design.

5.2. Predictions

From the perspective of memory-based accounts, we expected a main effect of distance, such that processing the long conditions is more difficult than processing the short conditions. The expectation-based accounts predict either no effect of distance or a facilitation at the verb as a function of distance. Also, a main effect of predictability is expected, such that there are faster reading times in strong versus weak conditions, regardless of distance. In other words, a facilitation effect is predicted in the long versus short conditions, as the more amount of information leads to less Surprisal.

We also expected that the second design in which less syntactic complexity (only one type of intervener) was included would be easier to process as compared to the first design where two chunks of different linguistic types were used as the intervener.

5.3. Summary of pre-tests

We conducted some pretests in order to make sure that our experimental stimuli are appropriate for the purpose of the main experiments. To this aim, two sentence-completion studies were done on two different groups of participants.

We were interested in whether the participants can predict the light verbs or heavy verbs we planned to use in the self-paced reading and eye-tracking experiments if they were given the sentence up to the pre-critical region. The aim was to ensure that the light verbs of the complex predicates were highly predictable (for strong predictability conditions) and the heavy verbs of the simple predicates had weak predictability, which was confirmed by these two studies.

Consequently, we managed to confirm that it was acceptable for the native speakers of Persian to separate the complex predicates used in the experimental sentences. Lastly, we used Persian corpora to show that the conditional probability of appearing the upcoming verb increases as the distance between the nominal and the light verb becomes larger. Also, a comparison of Persian and Hindi dependency treebanks showed that the adjacency of complex predicates is more preferred in Persian than in Hindi even though it can be considered acceptable as confirmed by our acceptability rating study. These studies helped us ensure that we had a well-designed setup so that we could proceed to the main experiments.

5.4. Summary of self-paced reading studies

In both self-paced reading experiments, there was a main effect of distance which was in favor of the memory-based accounts, that is, locality. In other words, lengthening the intervening materials led to more difficulty in processing. This effect was even stronger in the second experiment where the intervener was the same type, contrary to our expectation that keeping the same nature of the intervener can facilitate processing.

The response accuracy in both of these experiments was slightly higher in the short conditions versus long conditions even though there was no main effect of predictability to confirm that this difference was significant. **Figure 5.1** shows a summary of the first two experiments using self-paced reading method in which a main effect of distance and a marginal interaction between distance and predictability can be seen.

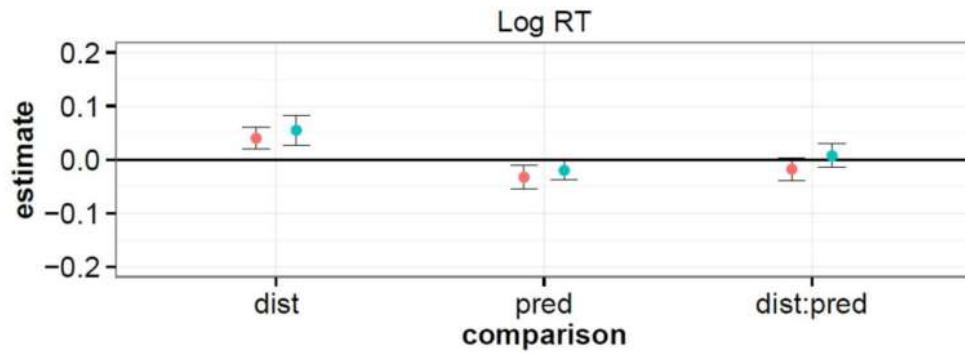


Figure 5.1. Summary of the magnitudes of effects (derived from the linear mixed models) across the two self-paced reading experiments. The error bars show 95% uncertainty intervals and show the range within which we can be 95% certain that the true parameter lies given the data. In this figure, ‘dist’ stands for distance, ‘pred’ stands for predictability, and ‘dist:pred’ stands for the interaction between these two factors. The red point refers to the first self-paced reading study, and the blue point refers to the second self-paced reading study.

5.5. Summary of eye-tracking studies

Eye-tracking method represents a more natural pattern of reading and provides more details on the proportion of eye-gaze (e.g. the first-pass reading time and the regression-path duration in which we were interested, as compared to the reading time data in the self-paced reading experiments). Similar to the self-paced reading experiments, the main effect of distance found in the First Pass Reading Time and Regression Path Duration as the two key eye-tracking measures was in favor of memory-based accounts, and there was no compelling evidence that the locality effects get weakened by strong predictability. It is worth mentioning that the locality effects are higher in strong predictability conditions compared to weak predictability conditions. Therefore, we failed to find evidence in favor of expectation-based account to conclude that increasing the distance between the noun and the verb leads to facilitation in processing due to increasing conditional probabilities of the

upcoming verb. The average response accuracy to the comprehension-check questions in both eye-tracking experiments was above 90 % which shows that the participants paid full attention to all parts of the sentences. However, there was no significant difference in the response accuracy across the conditions.

Below, there are two figures with graphical representation of the effects in the third and fourth main experiments (eye-tracking). **Figure 5.2** indicates the effects of the First Pass Reading Time whereas **Figure 5.3** belongs to Regression Path Duration. Figure and Figure show the summary of magnitude of effects for the first path reading time and regression path duration where the locality effect (main effect of distance) can be seen clearly.

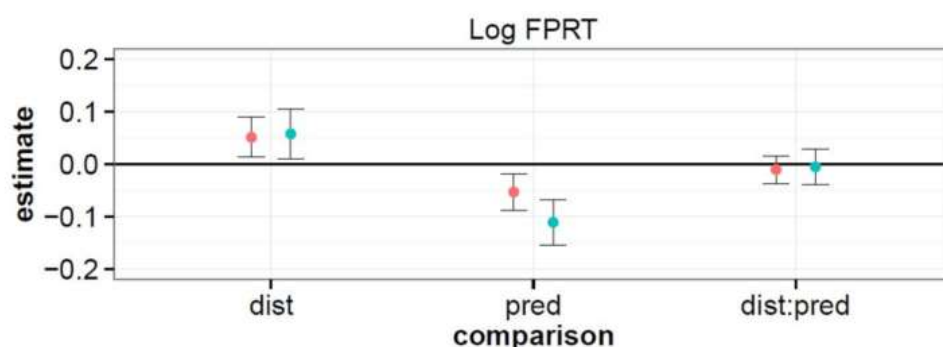


Figure 5.2. Summary of the magnitudes of effects (derived from the linear mixed models) across the two eye-tracking experiments in First Pass Reading Time (FPRT in the table). The error bars show 95% uncertainty intervals and show the range within which we can be 95% certain that the true parameter lies given the data. In this figure, ‘dist’ stands for distance, ‘pred’ stands for predictability, and ‘dist:pred’ stands for the interaction between these two factors. The red point refers to the first eye-tracking study, and the blue point refers to the second eye-tracking study.

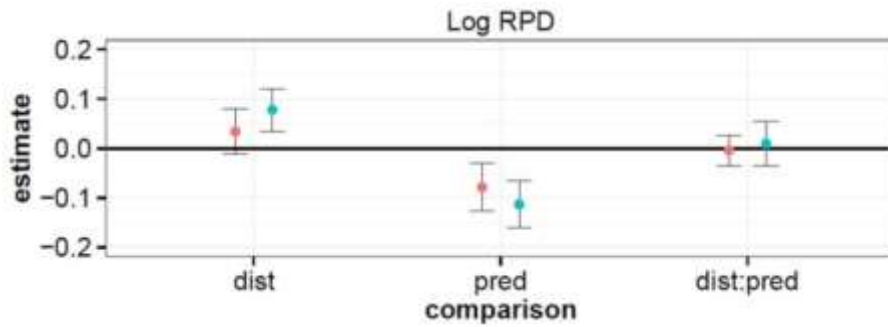


Figure 5.3. Summary of the magnitudes of effects (derived from the linear mixed models) across the two eye-tracking experiments in Regression Path Duration (RPD in the table). The error bars show 95% uncertainty intervals and show the range within which we can be 95% certain that the true parameter lies given the data. In this figure, ‘dist’ stands for distance, ‘pred’ stands for predictability, and ‘dist:pred’ stands for the interaction between these two factors. The red point refers to the first eye-tracking study, and the blue point refers to the second eye-tracking study.

5.6. General discussion

Dependency has been a main linguistic issue since the time of Panini (Percival, 1997), and dependency grammar (Tesnière, 1959) has shed new light to the way different levels of language can be interdependent. According to Mel’čuk (2009), there are different types of linguistic dependencies, out of which we aimed to investigate a particular type of syntactic dependency, namely complex predicates. Syntactic dependencies have also become an integral part of machine learning and computational linguistics since Hays’s work in 1972 up until recently that Depling series of conferences (2011, 2013, 2015) focused on dependency-based systems for generating dependency treebanks.

In the meanwhile, Fodor’s work on long-distance dependencies (1978) started a series of cognitive studies that resulted in theories of processing long-distance dependencies in the literature which are categorized into two major memory-based and expectation-based accounts. In the current dissertation, we have focused on separable complex predicates as an instance of a long-

distance dependency on which we investigated the locality and expectation effects using self-paced reading and eye-tracking experiments.

The kind of sentences we used to study the predictive processing were not garden-path sentences as we tried to avoid such ambiguities in the stimuli. We used Persian as a verb-final language in which complex predicates play a critical role in the syntax. In fact, there is a strong preference in Persian to use complex predicates over simple predicates which has made this language a great resource to study this construction (Sadeghi, 1993; Nemati, 2010). There are different types of complex predicates (DabirMoghaddam, 1997) out of which we investigate the noun-light verb type. The light verb is a semantically null verb which only has a functional role and indicates or confirms the occurrence of an action or event expressed by the dependent noun (Jespersen, 1965; Cattell, 1984; Grimshaw and Mester, 1988). As for the nature of complex predicates, one can generalize that they contain semantic, lexical, and syntactic information, and a differentiation between grammar and the lexicon is superfluous (Family, 2006). As we are interested in the processes underlying the long-distance dependency resolution, we investigated the separable types of Persian complex predicates which were previously evaluated in the acceptability pre-test based on Karimi-Doostan's (2011) criteria of separability.

What makes this Persian study different from Hindi study by Husain and colleagues (2014) is that the number of complex predicates in Persian is much larger than in Hindi. Also, in the Hindi experiment, only adverbials were used as the intervener while we were interested to know what will happen if we add more syntactic complexity to the intervening materials and manipulate the type of the intervener. Finally, separating the parts of complex predicates in Persian is not as common as it occurs in Hindi. In the following section, we

will discuss our results in the light of the theories discussed, relating them to the predictions we made in the beginning.

On the one hand, the Dependency Locality Theory defined in the framework of memory-based accounts (Gibson, 2000; Grodner and Gibson, 2005; Lewis and Vasishth, 2005; Demberg and Keller, 2008; Bartek et al., 2011; Vasishth and Drenhaus, 2011; among others) has been found in a variety of languages such as English (Gibson, 1998; 2000), Spanish (Cuetos and Mitchell, 1988), Dutch (Bach et al., 1986), Finnish (Hyönä and Hujanen, 1998), German (Bader et al., 1996; Hemforth, 1993), Russian (Levy et al., 2013), and Chinese (Hsiao and Gibson, 2003).

Considering our experimental design and stimuli in Persian, the memory-based accounts predict a slowdown at the verb as a function of increased distance, i.e., locality effects. However, they make no prediction about the strength of the predictability as this factor is not counted in their evaluation. In the first self-paced reading study, there is a main effect of distance such that the increased distance in the long conditions led to longer reading times. This effect persisted in the second self-paced reading study, as well. The results show that this locality effect is a bit stronger in the second self-paced reading study where there is only one type of intervener; however, this difference is not significant as analyzed by the Bayesian model. So, one can suggest that the complexity of the intervening material may strengthen the locality effect, but such a claim needs more investigations. In the first eye-tracking study (whose design is comparable to the first self-paced reading study), there was also a main effect of distance in the first-pass reading time. Nevertheless, this effect was not significant in the regression-path duration which indicates that by the time of regression, the reader is already done with the long-distance dependency resolution. In the second eye-tracking experiment, the main effect

of distance can be seen in both first-pass reading time and regression path duration. The fact that the reader faces more difficulty in retrieving the verb while regression (in the second eye-tracking study) may be relevant to the stronger locality effects seen in the second self-paced reading study, that is, it has something to do with the nature of the intervener which is more difficult to process as a long uninterrupted prepositional phrase although no relative clause is included. In sum, we can conclude that the results of all the four experiments were in line with the memory-based accounts, and to be specific, the Dependency Locality Theory (Gibson, 2000). However, as predictability is not included in the evaluation of these accounts, we will next analyze our data in light of the expectation-based account.

Expectation-based account, specifically Surprisal (Konieczny, 2000; Hale, 2001; Konieczny and Döring, 2003; Levy and Keller, 2013; Vasishth and Lewis, 2006; Levy, 2008; Husain et al., 2014; Jäger et al., 2015, among others) have been validated in languages like Hindi (Vasishth and Lewis, 2006; Husain et al., 2014), German (Konieczny, 2000; Vasishth and Drenhaus), and Russian (Levy and Keller, 2013). For the current Persian experiments, we divide the predictions of the expectation-based account into two parts. In the first prediction regarding the distance manipulation, it is expected that we have either no effect of distance or a facilitation at the verb as a function of distance. This key prediction of expectation-based account was not confirmed by our data as we consistently had a main effect of distance in all four experiments, resulting in more processing difficulty rather than facilitation.

However, regarding the predictability manipulation, faster reading time in strong predictability conditions versus weak predictability conditions is predicted regardless of distance if we measure Surprisal based on the

conditional probability of the exact identity of the verb (as calculated in our sentence-completion studies), not just some kind of verb. In the first self-paced reading study, there was a main effect of predictability such that the strong predictability conditions (i.e., complex predicate conditions) were read faster than the weak predictability conditions (i.e., simple predicate conditions). This effect was also seen in the second self-paced reading experiment with no significant difference between them across experiments. In the first eye-tracking study, there was also a main effect of predictability in both first-pass reading time and regression path duration in favor of the strong predictability conditions leading to facilitation at retrieving the verb. Finally, the predictability effect was even stronger in the second eye-tracking study measures of first pass reading time and regression path duration. Therefore, the main effect of predictability was consistent across the four experiments, and we can conclude that the second prediction of the expectation-based account is now validated with our data even though we failed to validate the first prediction of this account. It is worth mentioning that since the verbs in the strong and weak predictability conditions were not identical, we cannot rule out the possibility that word frequency or other such low-level factors are responsible for these effects.

In some studies, the interaction between locality and expectation effects have been investigated. For example, Staub (2010) found evidence for both effects in different regions of the target sentence. Also, there are researchers like Levy (2008) who argue that expectation plays a crucial role only when working memory load is low, and locality effects may occur when high working memory load is experienced. So, they suggest that the prediction of the upcoming word also depends on the working memory as the reader's expectation is also dependent on the information piled up on the reader's mind. Consequently, the individuals with decreased ability to manipulate

information and store it temporarily end up parsing the sentences at a lower pace compared to the individuals with higher working memory capacity when predicting the upcoming lexical items. Husain and colleagues (2014) also refer to this interaction from another perspective and argue that strong predictability for a head (i.e., predicting the exact lexical item) can cancel locality effects in Hindi. In their study, the noun predicted the exact identity of the verb in the strong predictability conditions, while in the weak predictability conditions, just ‘some’ verb was predicted. Their results showed a speedup with increased distance in the strong predictability conditions and a slowdown in weak predictability conditions.

In our experiments, we did not find a strong evidence in favor of interaction between locality and expectation effects except for a marginal significance in the first self-paced reading study. So we cannot conclude (as in Husain et al., 2014) that the strong predictability can cancel locality effects; however, we may be able to argue, based on the result of the first self-paced reading, that it might ‘weaken’ the locality effects. In order to test this claim, we need to run a within-subject experiment and include all the conditions of both experiments in one.

The reason why we have different results from the Husain and colleagues’ experiment can be related to the difference between the nature of the interveners as we have a more complex syntactic structure (i.e., relative clause and prepositional phrase) compared to their stimuli in which only adverbials intervened the parts of the complex predicates. Also, as confirmed by the corpus data discussed in chapter 2, the adjacency of the parts of complex predicates is more preferred in Persian compared to Hindi even though this separability is still tolerated as shown in the acceptability rating pre-test.

Levy (2008) argues that head-final syntactic dependencies can be the distinguishing factor between memory-based and expectation-based accounts. In such languages, there are several cases where the readers expect a specific word (i.e., head) to appear, but they do not know when it appears, as it is the case in languages like German (e.g., Konieczny, 2000) and Hindi (e.g., Vasishth and Lewis, 2006; Husain et al., 2014). In such cases, Dependency Locality Theory argues that a larger number of elements appearing before the head (i.e., the verb) will lead to more processing difficulty at the position of the upcoming head because all of these elements are supposed to be integrated simultaneously. Expectation-based accounts, however, predict it the other way round and expect a processing facilitation due to the increased information we receive about the upcoming head. Based on our data which are more in favor of memory-based accounts, we cannot confirm Levy's claim (2008) that verb-final languages show the patterns of memory-based accounts.

Our main finding from the four Persian studies is that the locality effect predicted by memory accounts is upheld, but there is no evidence for the expectation-based account's prediction of facilitation in longer distance conditions even though we consistently see a main effect of predictability, in line with expectation accounts. Finally, there is no compelling evidence in the Persian data that strong expectations cancel locality effects.

5.7. Concluding remarks

In conclusion, as regards the distance manipulation, the evidence from Persian is in favor of working memory accounts. Although we found a main effect of predictability in all four experiments, we cannot be certain that this effect is not due to other factors such as frequency as the words in the strong versus weak predictability conditions are not precisely the same. Also, there is not

much evidence from Persian that strong-predictability conditions cancel locality effects, as Husain and colleagues (2014) suggest. Interestingly, there is no evidence in these experiments for the prediction of the expectation-based account regarding the distance manipulation, that increasing argument-verb distance facilitates processing due to increasing conditional probabilities of the upcoming verb.

The suggestion in (Levy et al., 2013) that “the verb-medial languages tend to exhibit the general patterns predicted by memory-based theories, whereas verb-final languages tend to exhibit the general patterns predicted by expectation-based theories seems to be difficult to maintain (also see Husain et al. (2015), for locality effects in Hindi).

One implication of our findings from Persian is that locality and expectation effects observed across studies seem to be highly conditional on the language and syntactic construction being considered, so broad cross-linguistic generalizations may be difficult to make. To our best of knowledge, this is the first psycholinguistic experiment in Persian targeting the effects of memory and expectation on long-distance dependency resolution in sentence processing literature.

5.8. Further directions

A possible further research that can add more insights to the analysis of the experiments is a new design where we directly compare intervener types in a within-subject experiment, that is, the same participants read all the conditions in a 3 x 2 factorial design where the intervener in the first condition is a short prepositional phrase, in the second condition the combination of a prepositional phrase and a relative clause and in the third condition a long uninterrupted prepositional phrase for both simple predicate and complex

predicate conditions. This can be a definitive test to compare the differences directly.

Another possibility is to measure ‘entropy’ or uncertainty involved in sentence processing. Entropy is an information theory metric which may increase with increasing distance. We can use the probabilities of the sentence-completion data to measure this uncertainty. The increased entropy with distance can be an alternative explanation for the locality effects in the four experiments which can happen due to memory overload that causes forgetting, consequently, leading to processing difficulty. Also, another metric called ‘entropy reduction’ (Linzen and Jaeger, 2015) can be evaluated which requires that we know the entropy for the pre-critical region as well, either based on a new sentence-completion test where the participants are expected to predict the pre-critical region or based on the corpus data.

Comparing different groups of participants such as monolinguals versus bilinguals or agrammatical aphasic patients versus healthy adults can possibly shed new light to the way long-distance dependencies are resolved across languages, specially the ones with different word order. Finally, a co-registration study of event-related potentials and eye-tracking can provide more precise data on the neural activity involved in predictive processing of these syntactic structures.

Appendices

Appendix A. Experimental stimuli for the first self-paced reading and the first eye-tracking studies

1.

a.

Maryam	a:rezouyi	bara:ye	man	kard	ke	xeili	zud
Maryam	wish-INDEF	for	1.S	do-PST	which	very	soon
bara:vardeh	shod						
fulfilled	became						

‘Maryam wished something for me which very soon became fulfilled.’

b.

Maryam	a:rezouyi	ke	hamishe	dust-da:shtam	bara:ye	man
Maryam	wish-INDEF	which	always	like-1.S-PST	for	1.S
kard	ke	xeili	zud	bara:vardeh	shod	
do- PST	which	very	soon	fulfilled	became	

‘Maryam wished something which I always liked for me which very soon became fulfilled.’

c.

Maryam	qaza-i:	bara:ye	man	poxt	ke	xeili
Maryam	food-INDEF	for	1.S	cook-PST	which	very
xosh-mazeh	bud					
delicious	was					

‘Maryam cooked a food for me which was very delicious.’

d.

Maryam	qaza-i:	ke	hamishe	dust-da:shtam	bara:ye	man
Maryam	food-INDEF	which	always	like-1.S-PST	for	1.S
poxt	ke	xeili	xosh-mazeh	bud		
cook-PST	which	very	delicious	was		

‘Maryam cooked a food which I always liked for me which was very delicious.’

2.

a.

Ali	a:hangi	bara:ye	man	zad	va
Ali	music-INDEF	for	1.S	perform-PST	and
mara: be	sa:lha:ie	java:ni	bord		
1.S	to	years	adolescent	took	

‘Ali performed a music for me which took me to adolescent years.’

b.

Ali	a:hangi	ke	morede-alaghe'am	bud	ra:
Ali	a (piece of) music-INDEF	that	to-my-interest	was	ACCUS
baraye	man	zad	va	mara:	be

for me perform and me- ACCUS: to
 salhaye nojavani bord
 years-of teenage took
 ‘Ali performed a (piece of) music which was to my interest for me and took me to
 adolescent years.’

c.
 Ali shokolati baraye man xarid ke mazze'ash
 Ali chocolate-INDEF for me bought which its-flavor
 harf nadasht
 word didn't-have
 ‘Ali bought a chocolate for me whose taste was perfect.’

d.
 Ali shokolati ke moredeala:ghe'am bud ra:
 Ali chocolate-INDEF that to-my-interest was ACCUS
 baraye man xarid va mazze'ash harf nadasht
 for me bought and its-flavor word didn't have
 ‘Ali bought a chocolate which I always liked for me and its taste was perfect.’

3.

a.
 Madaram do'ayi baraye man kard ta hamishe
 My-mother prayer-INDEF for me did so-that always
 movaffagh basham
 successful be
 ‘My mother said a prayer for me so that I become successful.’

b.
 Madaram do'ayee ke besia:r ziba bud baraye man
 My-mother prayer-INDEF that very beautiful was for me
 kard ta hamishe movaffagh basham
 did so-that always successful be
 ‘My mother said a prayer which was very beautiful for me so that I become successful.’

c.
 madaram Lebasi baraye man duxt ta zemestan a:n
 My-mother dress-INDEF for me sewed so-that (in) winter that
 ra: bepusham
 ACCUS wear(i)
 ‘My mother sewed a dress for me so that I wear that in winter.’

d.
 madaram Lebasi ke besia:r ziba bud baraye man
 My-mother dress-INDEF that very beautiful was for me
 duxt Ta zemestan a:n ra: bepusham
 sewed so-that (in) winter that ACCUS wear(i)
 ‘My mother sewed a dress which was very beautiful for me so that I wear that in winter.’

4.

a.

Hamid	taghazayi	az	Mina	kard	va	montazere	javab
Hamid	request-INDEF	from	Mina	did	and	wait (for)	reply
shod							
become							

‘Hamid requested something from Mina and waited for reply.’

b.

Hamid	taghazayi	ke	kamelan	gheire-montazereh	bud
Hamid	request-INDEF	that	completely	Unexpected	was
az	Mina	kard	va	montazere	javab Shod
from	Mina	did	and	wait (for)	reply Did

‘Hamid requested something that was completely unexpected from Mina and waited for reply.’

c.

Hamid	javabi	az	Mina	shenid	va	shokkeh	shod
Hamid	reply-INDEF	from	Mina	heard	and	shocked	got

‘Hamid heard a reply from Mina and got shocked.’

d.

Hamid	javabi	ke	kamelan	gheire-montazere	bud	az
Hamid	reply-INDEF	that	completely	Unexpected	was	from
Mina	shenid	va	shokkeh	shod		
Mina	heard	and	shocked	got		

‘Hamid heard a reply that was completely unexpected from Mina and got shocked.’

5

a.

Hassan	shekayati	az	hamsaye'ash	kard	amma	ba'd
Hassan	complaint-INDEF	from	his-neighbor	did	but	then
az	u	ozr-xahi	kard			
from	him	apology	did			

‘Hassan made a complaint which was not logical at all from his neighbor but then apologized from him.’

b.

Hassan	shekayati	ke	aslan	manteghi	nabud	az
Hassan	complaint-INDEF	that	at-all	logical	was-not	from
hamsaye'ash	kard	amma	ba'd	az	u	ozr-xahi
his-neighbor	did	but	then	from	him	apology
						did

‘Hassan made a complaint which was not logical at all from his neighbor but then apologized from him.’

c.

Hassan	dastani	az	hamsaye'ash	shenid	va	
Hassan	story-INDEF	from	his-neighbor	heard	and	
nemidanest	bayad	a:n	ra:	bavar-konad	ya	na
didn't-know (if)	must	that	ACCUS	believe	or	not

‘Hassan heard a story which was not logical at all from his neighbour and didn’t know if she should believe it or not.’

d.

Hassan	dastani	ke	aslan	manteghi	nabud	az
Hassan	story-INDEF	that	at-all	logical	was-not	from
hamsaye'ash	shenid	va	nemidanest		bayad	a:n
his-neighbor	heard	and	didn't-know-(if)		must	that
ra:	bavar-konad	ya	na			
ACCUS	believe	or	not			

‘Hassan heard a story which was not logical at all from his neighbour and didn’t know if she should believe it or not.’

6

a.

xabarnegar		bardashti		az	harfe	man	kard
The-journalist		impression-INDEF		from	word (of)	me	did
dar-hali-ke	Dorost	nabud					
while	Correct	was-not					

‘The journalist got the impression he liked from my words while it was not correct.’

b.

xabarnegar		bardashti		ke	xodash	delash	mixast
The journalist		impression-INDEF		that	Himself	his-heart	wanted
az	harfe	man	kard	dar-hali-ke	Dorost	nabud	
from	word (of)	me	did	while	Correct	was-not	

‘The journalist got the impression he liked from my words while it was not correct.’

c.

xabarnegar	gozareshi	ke	xodash	delash	mixast	az
The journalist	report-INDEF	that	Himself	his-heart	wanted	from
harfe	man	nevesht	dar-hali-ke		Dorost	nabud
word (of)	me	wrote	while		Correct	was-not

‘The journalist wrote a report which he liked from my words while it was not correct.’

d.

xabarnegar	gozareshi	az	harfe	man	nevesht	dar-hali-ke
The journalist	report-INDEF	from	word (of)	me	wrote	while
dorost	nabud					
correct	was-not					

‘The journalist wrote a report from my words while it was not correct.’

7.

a.

Sepideh	tahlili		az	maghaleh	kard	va	a:n
Sepideh	analysis-INDEF		from	(the) article	did	and	that
ra:	dar	conferans	era'eh-dad				
ACCUS	in	conference	presented				

‘Sepideh made an analysis from the article and presented it in the conference.’

b.

Sepideh	tahlili		ke	be	nazar	pichideh	mi-amad
---------	---------	--	----	----	-------	----------	---------

Sepideh analysis-INDEF that to eye complicated seemed
 az maghaleh kard va a:n ra: dar conferans
 from (the) article did and that ACCUS in conference era'eh-dad
 presented

‘Sepideh made an analysis which seemed complicated from the article and presented it in the conference.’

c.

Sepideh Naghdi az maghaleh xa:nd va dar
 Sepideh criticism-INDEF from (the) article read and in
 soxanranie xod be a:n eshare-kard
 presentation (of) himself to that pointed

‘Sepideh read a criticism from the article and pointed to that in her presentation.’

d.

Sepideh Naghdi ke be nazar pichideh mi-amad
 Sepideh criticism-INDEF that to eye complicated seemed
 az maghaleh xand va dar soxanranie xod
 from (the) article read and in presentation (of) himself
 be a:n eshare-kard
 to that pointed

‘Sepideh read a criticism which seemed complicated from the article and pointed to that in her presentation.’

8.

a.

Sara Entezari az man dasht va man nemitavanestam
 Sara expectation-INDEF from me had and I could-not
 a:n ra: baravardeh-konam
 that ACCUS meet

‘Sara had an expectation from me and I could not meet that.’

b.

Sara Entezari ke barayam sa:xt bud az man
 Sara expectation-INDEF that for-me difficult was from me
 dasht va man nemitavanest a:n ra: baravardeh-konam
 had and I could-not that ACCUS meet

‘Sara had an expectation which was difficult for me from me and I could not fulfill that.’

c.

Sara Darxa:sti az man dasht va man nemitavanestam
 Sara request-INDEF from me had and I couldn't
 a:n ra: baravardeh-konam
 that ACCUS meet

‘Sara had a request from me and I could not fulfill that.’

d.

Sara Darxasti ke barayam saxt bud az man
 Sara request-INDEF that for-me difficult was from me
 dasht va man nemitavanestam a:n ra:
 had and I couldn't that ACCUS

baravardeh-konam

meet

‘Sara had a request which was difficult for me from me and I could not fulfill that.’

9.

a.

Hamkaram sahmi az sherkat bord dar-hali-ke
My colleague share-INDEF from (the) company won while
man bishtar az u baraye sherkat
I more than him for (the)company
zahmat-keshideh-budam
had-toiled

‘My colleague won a share from the company while I had toiled more than him for the company.’

b.

Hamkaram sahmi ke besia:r na-adelaneh bud az
My-colleague share-INDEF that very unfair was from
sherkat bord dar-hali-ke man bishtar az u
(the) company won while I more than him
baraye sherkat zahmat-keshideh-budam
for (the) company had-toiled

‘My colleague won a share that was very unfair from the company while I had toiled more than him for the company.’

c.

Hamkaram enteghadi az sherkat dasht amma
My-colleague criticism-INDEF from (the) company had but
natavanest heiat-modireh ra: motegha'ed-konad
could-not board-of-directors ACCUS persuade

‘My colleague had a criticism from the company but could not persuade the board of directors.’

d.

Hamkaram enteghadi ke besia:r na-adelaneh bud
My colleague criticism-INDEF that very unfair was
az sherkat dasht amma natavanest heiat-modireh
from (the) company had but could-not board-of-directors
ra: motegha'ed konad
ACCUS persuade

‘My colleague had a criticism which was very unfair from the company but could not persuade the board of directors.’

10

a.

Man xa:heshi az Mahsa : kadam amma
I request-INDEF from Mahsa did-1.S but
u a:n ra: rad-kard
she that ACCUS rejected

‘I requested something from Mahsa but she rejected that.’

b.
 Man xa:heshi ke besia:r na-chiz bud az Mahsa
 I request-INDEF that very trifle was from Mahsa
 kardam amma u a:n ra: rad-kard
 did-1.S but she that ACCUS rejected
 'I requested something that was trifle from Mahsa but she rejected that.'

c.
 man Puli az Mahsa : gereftam chon
 I money-INDEF from Mahsa got because
 kifam ra: dar xa:neh ja-gozashte-budam
 my-purse ACCUS at home had-left(i)
 'I got some money from Mahsa because I had left my purse at home.'

d.
 man Puli ke besia:r na-chiz bud az Mahsa
 I money-INDEF that very trifle was from Mahsa
 gereftam Chon kifam ra: dar xa:neh
 got because my-purse ACCUS at home
 ja-gozashte-budam
 had-left(i)
 'I got some money which was trifle from Mahsa because I had left my purse at home.'

11

a.
 Elham atri ra: be lebasash zad va
 Elham perfume-INDEF ACCUS to her dress hit and
 tavajjohe hame ra: jalb-kard
 attention (of) all ACCUS drew
 'Elham used a perfume on her dress and had attracted everyone's attention.'

b.
 Elham atri ke hedyeye tavallodash bud
 Elham perfume-INDEF that gift (of) her-birthday was
 ra: be lebasash zad va tavajjohe hame
 ACCUS to her dress hit and attention (of) all
 ra: jalb kard
 ACCUS drew
 'Elham used a perfume that was a present for her birthday on her dress and had attracted everyone's attention.'

c.
 Elham sanjaghi ra: be lebasash a:vixt va
 Elham clips-INDEF ACCUS to her-dress hang and
 tavajjohe hame ra: jalb-kard
 attention (of) all ACCUS drew
 'Elham hanged a clip to her dress and attracted everyone's attention.'

d.
 Elham sanjaghi ke hedyeye tavallodash bud
 Elham clips-INDEF that gift (of) her-birthday was

ra:	be	lebasash	a:vixt	va	tavajjohe
ACCUS	to	her-dress	hang	and	attention (of)
hame ra:		jalb kard			
all	ACCUS	drew			

‘Elham hanged a clip that was a present for her birthday to her dress and attracted everyone’s attention.’

12

- a.
- | | | | | | | | |
|--------|------------------|----|-----|-----|------|------------|------|
| Mohsen | ettehami | be | Man | zad | amma | natavanest | a:n |
| Mohsen | accusation-INDEF | to | Me | hit | but | could-not | that |
| ra: | sabet-konad | | | | | | |
| ACCUS | prove | | | | | | |
- ‘Mohsen accused me of something but did not manage to prove it.’
- b.
- | | | | | | |
|------------|------------------|------|--------|-----------------------|------------|
| Mohsen | ettehami | ke | aslan | entezarash | ra: |
| Mohsen | accusation-INDEF | that | at-all | expectation (of that) | ACCUS |
| nadashtam | be | Man | zad | amma | natavanest |
| didn't (i) | to | Me | hit | but | could not |
| ra: | sabet-konad | | | | that |
| ACCUS | prove | | | | |
- ‘Mohsen accused me of something that I did not expect at all but did not manage to prove it.’
- c.
- | | | | | | | |
|----------|--------------|---------|-----|-----------|-----|---------|
| Mohsen | ra:zi | be | Man | goft | va | hesabi |
| Mohsen | secret-INDEF | to | Me | said | and | so-much |
| mara: | dar | fekr | | foru-bord | | |
| me-ACCUS | in | thought | | Drowned | | |
- ‘Mohsen told a secret to me and made me get drowned in my thoughts.’
- d.
- | | | | | | |
|----------------|--------------|---------|--------|-----------------------|---------|
| Mohsen | ra:zi | ke | aslan | entezarash | ra: |
| Mohsen | secret-INDEF | that | at-all | expectation (of that) | ACCUS |
| nadashtam | be | Man | goft | va | hesabi |
| didn't-have(i) | to | Me | said | and | so-much |
| mara | dar | fekr | | foru-bord | |
| me-ACCUS | in | thought | | Drowned | |
- ‘Mohsen told a secret that I did not expect at all to me and made me get drowned in my thoughts.’

13

- a.
- | | | | | | | | | | |
|--------------------|-------------|----|-----|-----|-----|-----|--------|------|-------|
| Reza | labxandi | be | Man | zad | va | man | hargez | a:n | ra: |
| Reza | smile-INDEF | to | Me | hit | and | I | never | that | ACCUS |
| faramush-nemikonam | | | | | | | | | |
| forget | | | | | | | | | |
- ‘Reza smiled at me and I will never forget that.’

b.

Reza labxandi ke sarshar az aramesh bud be Man
Reza smile-INDEF that full of comfort was to Me
zad va man hargez a:n ra: faramush-nemikonam
hit and I never that ACCUS forget
'Reza smiled at me somehow that was full of calmness and I will never forget that.'

c.

Reza baghi be Man foruxt va az in shahr
Reza garden-INDEF to Me sold a:nd from this city
raft
went

'Reza sold a garden which was full of comfort to me and left this city.'

d.

Reza baghi ke sarshar az aramesh bud be
Reza garden-INDEF that full of comfort was to
Man foruxt va az in shahr raft
Me sold and from this city went

'Reza sold a garden which was full of comfort to me and left this city.'

14

a.

Mojgan tohmati be man Zad va ba'es-shod ba u
Mojgan insult-INDEF to me Hit and caused with her
ghat'e-ra:beteh konam
cut-relation do (i)

'Mojgan insulted me and caused me to cut my relations to her.'

b.

Mojgan tohmati ke barayam bavar-nakardani bud be
Mojgan insult-INDEF that for-me unbelievable was to
man Zad va ba'es-shod ba u ghat'e-ra:beteh konam
me Hit and caused with her cut-relation do (i)

'Mojgan insulted me somehow that was unbelievable for me and caused me to cut my relations to her.'

c.

Mojgan hedyei be man Dad va man hesabi
Mojgan gift-INDEF to me gave and I so-much
zogh-zadeh shodam
excited got

'Mojgan gave a gift to me and I got so excited.'

d.

Mojgan hedyei ke barayam bavar-nakardani bud be
Mojgan gift-INDEF that for-me unbelievable was to
man Dad va man hesabi zogh-zadeh shodam
me gave and I so-much excited got

'Mojgan gave a gift that was unbelievable to me and I got so excited.'

15

a.
 hamsaram zarbei be zendegiam zad va zendegie
 My spouse damage-INDEF to my-life hit and life (of)
 mara: az in ru be a:n ru kard
 me-ACCUS from this face to that face did
 'My spouse made a damage to my life and changed my life drastically.'

b.
 hamsaram zarbei ke aslan entezar nadashtam be
 My spouse damage-INDEF that at-all expect didn't have (i) to
 zendegiam zad va zendegie mara: az in ru
 my life hit and life (of) me-ACCUS from this face
 be a:n ru kard
 to that face did
 'My spouse made a damage that I did not expect to my life and changed my life drastically.'

c.
 Hamsaram shadi be zendegiam avarad va
 My spouse happiness-INDEF to my life brought and
 zendegie mara: az in ru be a:n ru kard
 life (of) me-ACCUS from this face to that face did
 'My spouse brought a happiness that I did not expect at all to my life and change my life drastically.'

d.
 Hamsaram shadi ke aslan entezar nadashtam
 My spouse happiness-INDEF that at-all expect didn't-have (i)
 be zendegiam avarad va zendegie mara: az
 to my life brought and life (of) me-ACCUS from
 in ru be a:n ru kard
 this face to that face did
 'My spouse brought a happiness that I did not expect at all to my life and change my life drastically.'

16

a.
 Farzad harfi be man Zad va az otagh
 Farzad word-INDEF to me Hit and from (the) room
 xarej shod
 went out
 'Farzad said something to me and left the room.'

b.
 Farzad harfi ke besia:r ja:leb bud be man
 Farzad word-INDEF that very interesting was to me
 zad va az otagh xarej-shod
 hit and from (the) room went-out
 'Farzad said something that was very interesting to me and left the room.'

c.

Farzad	ketabi		be	man	Dad	amma	hanuz
Farzad	book-INDEF		to	me	Gave	but	still
forsat	nakardam	a:n	ra:		bexanam		
chance	didn't do	that	ACCUS		read		

'Farzad gave a book to me but I still haven't had the chance to read it.'

d.

Farzad	ketabi		ke	besia:r	jaleb	bud	be
Farzad	book-INDEF		that	very	interesting	was	to
man	dad	amma	hanuz	forsat	nakardam	a:n	
me	gave	but	still	chance	didn't do	that	
ra:	bexanam						
ACCUS	read						

'Farzad gave a book which was very interesting to me but I still haven't had the chance to read it.'

17

a.

moallemam	tosieii		be	man	kard	va	man
My-teacher	recommendation-INDEF		to	me	did	and	I
say-kardam	a:n	ra:		be-kar-bebandam			
tried	that	ACCUS		put-into-practice			

'My teacher gave a recommendation to me and I tried to put it into practice.'

b.

moallemam	tosiei:		ke	besia:r	mofid	bud	be
My teacher	recommendation-INDEF		that	very	useful	was	to
man	kard	va	man	say-kardam	a:n	ra:	
me	did	and	I	tried	that	ACCUS	

be-kar-bebandam

put-into-practice

'My teacher gave a recommendation which was very helpful to me and I tried to put it into practice.'

c.

moallemam	darsi	be	man	amuxt	va	man	a:n
My-teacher	lesson-INDEF	to	me	taught	and	I	that
ra:	hargez		faramush-nemikonam				
ACCUS	never		forget				

'My teacher taught a lesson to me and I never forget that.'

d.

moallemam	darsi	ke	besia:r	mofid	bud	be	man
My teacher	lesson-INDEF	that	very	useful	was	to	me
amuxt	va	man	a:n	ra:	hargez		
taught	and	I	that	ACCUS	never		

faramush-nemikonam

forget

'My teacher taught a lesson which was very helpful to me and I never forget that.'

18

- a.
Kourosh nasihati be man kard va man a:n
Kourosh advice-INDEF to me did and I that
ra: gush dadam
ACCUS listened
'Kourosh gave an advice to me and I listened to that.'
- b.
Kourosh nasihati ke be naf'am bud be man
Kourosh advice-INDEF that to my benefit was to me
kard va man a:n ra: gush dadam
did and I that ACCUS listened
'Kourosh gave an advice which was to my benefit to me and I listened to that.'
- c.
Kourosh noktei be man fahmand va man taze
Kourosh point-INDEF to me made across and I just
haghighat ra: fahmidam
(the) truth ACCUS understood
'Kourush explained a point to me and I just understood that truth.'
- d.
Kourosh noktei ke be naf'am bud be man
Kourosh point-INDEF that to my interest was to me
fahmand va man taze haghighat ra: fahmidam
made across and I just (the) truth ACCUS understood
'Kourush explained a point which was to my interest to me and I just understood that truth.'

19

- a.
Shabnam pishnahadi be man kard va man a:n
Shabnam suggestion-INDEF to me did and I that
ra: ghabul kardam
ACCUS accepted
'Shabnam made a suggestion to me and I accepted that.'
- b.
Shabnam pishnahadi ke be nazar ba-arzesh mi-amad be
Shabnam suggestion-INDEF that to eye valuable seemed to
man Kard va man a:n ra: ghabul kardam
me Did and I that ACCUS accepted
'Shabnam made a suggestion that seemed valuable to me and I accepted that.'
- c.
Shabnam tablo'i be man baxshid va man a:n
Shabnam picture-INDEF to me spared and I that
ra: be divar zadam
ACCUS to (the) wall attached (i)
'Shabnam spared a picture to me and I attached that to the wall.'

d.
 Shabnam tablo'i ke be-nazar ba-arzesh mi-amad
 Shabnam picture-INDEF that to-eye valuable seemed
 be man baxshid va man a:n ra: be
 to me spared and I that ACCUS to
 divar zadam
 (the) wall attached (i)
 'Shabnam spared a picture which seemed valuable to me and I attached that to the wall.'

20

a.
 Behnam ra:hnamayi ra: be Man kard va
 Behnam guidance-INDEF ACCUS to Me did and
 ba'es shod betavanam tasmimam ra: begiram
 caused (that) Can (i) my decision ACCUS take (i)
 'Behnam gave a guidance and that caused me to be able to make my decision.'

b.
 Behnam ra:hnamayi ke moddat-ha donbalash
 Behnam guidance-INDEF that (for) long time looking for
 budam ra: be Man kard va ba'es shod
 was (i) ACCUS to Me did and caused (that)
 betavanam tasmimam ra: begiram .
 can (i) my decision ACCUS take (i)
 'Behnam gave a guidance that I was looking for for a long time to me and that caused me to be able to make my decision.'

c.
 Behnam maghale'ii ra: be Man dad va
 Behnam article-INDEF ACCUS to Me gave and
 hesabi karam ra: jolo-andaxt .
 so much my work ACCUS progressed
 'Behnam gave an article to me and progressed my work a lot.'

d.
 Behnam maghale'ii ke moddat-ha donbalash
 Behnam article-INDEF that (for) long time looking for
 budam ra: be Man dad va hesabi
 was (i) ACCUS to Me gave and so much
 karam ra: jolo-andaxt .
 my work ACCUS progressed
 'Behnam gave an article which I was looking for for a long time to me and progressed my work a lot.'

21

a.
 hamsaye'am tazakkori be dustam dad va az u
 My neighbor point-INDEF to my friend gave and from him/her
 xast kamtar sigar-bekeshad

wanted less smoke

'My neighbour gave a point to my friends and asked him/her to smoke less.'

b.

hamsaye'am tazakkori ke kamelan be moghe' bud be
 My neighbor point-INDEF that completely timely was to
 Dustam dad va az u xast kamtar sigar-bekeshad
 my friend gave and from him/her wanted less smoke
 'My neighbour gave a point which was completely timely to my friends and asked
 him/her to smoke less.'

c.

Hamsaye'am davayi be dustam resand va
 My-neighbord medication-INDEF to my-friend fetched and
 jane u ra: nejat-dad
 life (of) him/her ACCUS saved
 'My neighbour fetched a medication which was completely timely for my friend and save
 his/her life.'

d.

Hamsaye'am davayi ke kamelan be-moghe bud
 My-neighbord medication-INDEF that completely timely was
 be dustam resand va jane u ra:
 to my-friend fetched and life (of) him/her ACCUS
 nejat-dad
 saved
 'My neighbour fetched a medication which was completely timely for my friend and save
 his/her life.'

22

a.

Nima sefareshi be man Kard va az man xast
 Nima request-INDEF to me Did and from me wanted
 ke moraghebe xaharash Basham
 that looking-after his-sister am (i)
 'Nima requested something which was very life-saving from me and asked me to take
 care of his sister.'

b.

Nima sefareshi ke besia:r haya:ti bud be man
 Nima request-INDEF that very life-saving was to me
 kard va az man xast ke moraghebe xaharash
 did and from me wanted that looking-after his-sister
 Basham
 am (i)

'Nima requested something which was very life-saving from me and asked me to take
 care of his sister.'

c.

Nima amanati be man sepord va az man xast
 Nima borrowing-INDEF to me Gave and from me wanted

ta a:n ra: Be daste xaharash beresanam
 so-that that ACCUS To hand (of) his sister take (i)
 ‘Nima gave a borrowing to me and asked me to take it to his sister.’

d.

Nima amanati ke besia:r haya:ti bud be man
 Nima borrowing-INDEF that very life-saving was to me
 sepord va az man xast ta a:n ra: Be
 gave and from me wanted so-that that ACCUS To
 daste xaharash beresanam
 hand (of) his-sister take (i)

‘Nima gave a borrowing which was very life-saving to me and asked me to take it to his sister.’

23

a.

adam-roba-ha hoshdari be man dadand va az
 The kidnappers warning-INDEF to me gave and from
 man xastand ta pul ra: harche
 me wanted to (the) money ACCUS whatever
 zudtar amadeh-konam vagarna pesaram ra:
 sooner prepare(i) otherwise my son ACCUS
 mikoshand
 kill(they)

‘The kidnappers gave a warning to me and asked me to prepare the money as soon as possible or else they will kill my son.’

b.

adam-roba-ha hoshdari ke besia:r jeddi bud
 The kidnappers warning-INDEF that very serious was
 be man dadand va az man xastand ta
 to me gave and from me wanted to
 pul ra: harche zudtar amadeh-konam
 (the) money ACCUS whatever sooner prepare(i)
 vagarna pesaram ra: mikoshand
 otherwise my son ACCUS kill(they)

‘The kidnappers gave a warning which was very serious to me and asked me to prepare the money as soon as possible or else they will kill my son.’

c.

adam-roba-ha extari be man ferestadand va az
 The kidnappers alarm-INDEF to me sent and from
 man xastand ta pul ra: harche
 me wanted to (the) money ACCUS whatever
 zudtar amadeh-konam vagarna pesaram ra:
 sooner prepare(i) otherwise my son ACCUS
 mikoshand
 kill(they)

‘The kidnappers sent an alarm to me and asked me to prepare the money as soon as possible or else they will kill my son.’

d.

adam-roba-ha	extari	ke	besia:r	jeddi	bud	be
The kidnappers	alarm-INDEF	that	very	serious	was	to
man ferestadand	va	az	man	xastand	ta	pul
me sent	and	from	me	wanted	to	(the) money
ra:	harche	zudtar	amadeh-konam	vagarna		
ACCUS	whatever	sooner	prepare(i)	otherwise		
pesaram	ra:	mikoshand				
my son	ACCUS	kill(they)				

‘The kidnappers sent an alarm which was very serious to me and asked me to prepare the money as soon as possible or else they will kill my son.’

24

a.

Farhad	gholi	be	man	Dad	va	digar
Farhad	promise-INDEF	to	me	Gave	and	from that time
xialam	ra:hat-shod					
my soul	got-relaxed					

‘Farhad promised something to me and made me relaxed.’

b.

Farhad	gholi	ke	besia:r	omid-baxsh	bud
Farhad	promise-INDEF	that	very	promising	was
be man	Dad va	digar	xialam	ra:hat-shod	
to me	Gave and	from-that-time	my soul	got-relaxed	

‘Farhad promised something that was very promising to me and made me relaxed.’

c.

Farhad xabari	be	man	Dad	va	mara:	az
Farhad news-INDEF	to	me	Gave	and	me-ACCUS	from
negarani	dar-avard					
worry	took-out					

‘Farhad gave a piece of news which was very promising to me and helped not worry anymore.’

d.

Farhad xabari	ke	besia:r	omid-baxsh	bud	be
Farhad news-INDEF	that	very	promising	was	to
man dad va	mara:	az	negarani	dar-avard	
me gave and	me-ACCUS	from	worry	took-out	

‘Farhad gave a piece of news which was very promising to me and helped not worry anymore.’

25

a.

Mitra dorughi	be	man	Goft	amma	ba'd	dastash
Mitra lie-INDEF	to	me	Told	but	then	her hands
ru shod						
got caught						

‘Mitra told a lie to me but then the truth was discovered.’

b.

Mitra dorughi ke vaghei be nazar miresid be
 Mitra lie-INDEF that real to eye seemed to
 man Goft amma ba'd dastash ru shod
 me Told but then her hands got caught
 'Mitra told a lie which seems real to me but then the truth was discovered.'

c.

Mitra arusaki be man Dad va man a:n ra: az
 Mitra doll-INDEF to me Gave and I that ACCUS from
 xodam joda nemikardam
 my self didn't separate
 'Mitra gave a doll which seemed real to me and I used to never separate it from me.'

d.

Mitra arusaki ke vaghei be nazar miresid be man
 Mitra doll-INDEF that real to eye seemed to me
 dad va man a:n ra: az xodam
 gave and I that ACCUS from my self
 joda nemikardam
 didn't separate
 'Mitra gave a doll which seemed real to me and I used to never separate it from me.'

26

a.

Nilufar pishrafti dar madreseh Kard va az moallemash
 Nilufar progress-INDEF at school Did and from her teacher
 jayezeh gereft
 prize got
 'Nilufar had a progress which she had promised in school and got a prize from her teacher.'

b.

Nilufar pishrafti ke gholash ra: dadeh bud
 Nilufar progress-INDEF that promise (of that) ACCUS had given
 dar madreseh Kard va az moallemash jayezeh gereft
 at school Did and from her teacher prize got
 'Nilufar had a progress which she had promised in school and got a prize from her teacher.'

c.

Nilufar deklamei dar madrese xand va jayezeye
 Nilufar composition-INDEF at school Read and prize (of)
 behtarin deklameye mantagheh ra: gereft
 (the) best composition(of) (the) region ACCUS got
 'Nilufar read the composition she had promised at school and got the prize of the best composition of the region.'

d.

Nilufar deklamei ke gholash ra:
 Nilufar composition-INDEF that promise (of that) ACCUS

dadeh bud dar madrese xand va jayezeye behtarin
 had given at school Read and prize (of) (the) best
 deklameye mantagheh ra: gereft
 composition (of) (the) region ACCUS got
 ‘Nilufar read the composition she had promised at school and got the prize of the best composition of the region.’

27

a.
 Majid lotfi be man kard va man hamishe be u
 Majid favor-INDEF to Me did and I always to him
 madiunam
 owe (i)
 ‘Majid did a favor to me and I always owe him.’

b.
 Majid lotfi ke dur az zehn bud be man kard va
 Majid favor-INDEF that far from mind was to Me did and
 man hamishe be u madiunam
 I always to him owe (i)
 ‘Majid did a favor that was far from mind to me and I always owe him.’

c.
 Majid nasezayi be Man goft va man ta omr daram
 Majid swearword-INDEF to Me said and I till life have
 faramush-nemikonam
 don't-forget
 ‘Majid said a swear word to me and I will never forget him till I am alive.’

d.
 Majid nasezayee ke dur az zehn bud be Man goft
 Majid swearword-INDEF that far from mind was to Me said
 va man ta omr daram faramush nemikonam
 and I till life have don't forget
 ‘Majid said a swear word that was far from mind to me and I will never forget him till I am alive.’

28

a.
 ostad Sohbat ba shagerdash kard va
 (The) professor word-INDEF to his/her student did and
 u ra: motegha'ed-kard ke tasmimash
 him/her ACCUS persuaded that his/her decision
 ra: avaz konad
 ACCUS change
 ‘The professor said something to his/her students and he/she got persuaded to change his/her decision.’

b.
 ostad Sohbat ke besia:r asargozar bud

(The) professor word-INDEF that very impressive was
 ba shagerdash kard va u ra:
 to his/her student did and him/her ACCUS
 motegha'ed-kard ke tasmimash ra: avaz konad
 persuaded that his/her decision ACCUS change
 'The professor said something which was very impressive to his/her students and he/she
 got persuaded to change his/her decision.'

c.

Ostad ghat'ei ba shagerdash navaxt va
 (the)-professor piece-INDEF with his/her student played and
 jamiat hesabi tashvigheshan kardand
 (the) crowd so much clapped (for them)
 'The professor played a piece with his/her students which was very impressive and the
 crowd clapped a lot for him/her.'

d.

Ostad ghat'ei ke besia:r asar-gozar bud
 (the)-professor piece-INDEF that very impressive was
 ba shagerdash navaxt va jamiat hesabi
 with his/her student played and (the) crowd so much
 tashvigheshan kardan
 clapped (for them)
 'The professor played a piece with his/her students which was very impressive and the
 crowd clapped a lot for him/her.'

29

a.

Sina gharari ba Neda gozasht amma u sare
 Sina appointment-INDEF with Neda put But she to
 gharar nayamad
 (the) appointment didn't come

'Sina made an appointment with Neda but she did not show up.'

b.

Sina gharari ke entezarash ra: mikeshid ba
 Sina appointment-INDEF that expected ACCUS had with
 Neda gozasht amma u sare gharar nayamad
 Neda put But she to (the) appointment didn't come

'Sina made an appointment which he was waiting for with Neda but she did not show
 up.'

c.

Sina safari ke ba Neda raft va be a:nha:
 Sina travel-INDEF which with Neda went and to them
 xeili xosh gozasht
 very much fun was

'Sina went on a trip with Neda and they had lots of fun.'

d.

Sina	safari			ke	entezarash	ra:	mikeshid	ba
Sina	travel-INDEF			that	expected	ACCUS	had	with
Neda	raft	va	be	a:nha:	xeili	xosh gozasht		
Neda	went	and	to	them	very much	fun was		

‘Sina went on a trip which he was waiting for with Neda and they had lots of fun.’

30

a.

Man	hadsi		dar morede	Setarehzadam	va	xeili	dir	motevajjeh
I	guess-INDEF		about	Setarehhit (i)	and	very	late	realize
shodam		ke	hadsam	dorost		nabudeh	ast	
did		that	my guess	correct		was not		

‘I guessed something about Setareh and figured out very late that it was not correct.’

b.

Man	hadsi		ke	eshtebah	az	ab	dar-amad	dar morede
I	guess-INDEF		that	mistake	from	water	came out	about
Setareh		zadam	va	xeili	dir	motevajjeh	shodam	ke
Setareh		hit (i)	and	very	late	realize	did	that
hadsam		dorost		nabudeh	ast			
my guess		correct		was not				

‘I guessed something which turned out to be wrong about Setareh and figured out very late that it was not correct.’

c.

man	shaye'ei		dar morede	Setareh	shenidam	va	xeili
I	rumor-INDEF		about	Setareh	Heard (i)	and	very
asabani		shodam					
angry		was (i)					

‘I heard a rumor about Setareh and got very angry.’

d.

man	shaye'ei		ke	eshtebah	az	ab	dar-amad
I	rumor-INDEF		that	wrong	from	water	came-out
dar morede	Setareh		shenidam	va	xeili	asabani	
about	Setareh		Heard (i)	and	very	angry	
shodam							
was (i)							

‘I heard a rumor which turned out to be wrong about Setareh and got very angry.’

31

a.

Pejman		ghezavati		dar-morede	man	kard	amma	motevajjehe
Pejman		judgement-INDEF		about	me	did	But	realize
eshtebahash		shod						
his mistake		got						

‘Pejman made a judgement about me but realized his mistake.’

b.

Pejman		ghezavati		ke	aslan	monsefaneh	nabud
Pejman		judgement-INDEF		that	at all	fair	was not

darmorede man kard amma motevajehe eshtebahash shod
 about me did But realize his mistake got
 'Pejman made a judgement which was not fair at all about me but realized his mistake.'

c.

Pejman xabari dar-morede man shenid amma a:n ra:
 Pejman news-INDEF about me heard but that ACCUS
 bavar nakard
 didn't believe

'Pejman heard a piece of news about me but he did not believe it.'

d.

Pejmanxabari ke aslan monsefaneh nabud dar-morede man
 Pejmannews-INDEF that at all fair was not about me
 shenid amma a:n ra: bavar nakard
 heard but that ACCUS didn't believe

'Pejman heard a piece of news which was not fair at all about me but he did not believe it.'

32

a.

Kaveh hessi dar morede Parisa mi-kard va man in
 Kaveh feeling-INDEF about Parisa did and I this
 ra: az negahash mixandam
 ACCUS from his look read

'Kaveh had a feeling about Parisa and I could read this his look.'

b.

Kaveh hessi ke barayash ajib bud dar morede Parisa
 Kaveh feeling-INDEF that for him weird was about Parisa
 mi-kard va man in ra: az negahash
 did and I this ACCUS from his look
 mixandam
 read

'Kaveh had a feeling which was weird for him about Parisa and I could read this his look.'

c.

Kaveh vagheiati dar morede Parisa Fahmid amma be ruye
 Kaveh truth-INDEF about Parisa understood but to face (of)
 xodash nayavard
 face didn't bring

'Kaveh found out a truth about Parisa but he did not mention it.'

d.

Kaveh vagheiati ke barayash ajib bud dar morede Parisa
 Kaveh truth-INDEF that for him weird was about Parisa
 Fahmid amma be ruye xodash nayavard
 understood but to face (of) face didn't bring

'Kaveh found out a truth which was weird for him about Parisa but he did not mention it.'

33

a.
 Hamed estedlali dar-morede mas'aleh kard vali
 Hamed reasoning-INDEF about (the) matter did But
 natavanest ostadash ra: mojab konad
 could not his professor ACCUS convince
 'Hamed made a reasoning about the problem but did not manage to convince his professor.'

b.
 Hamed estedlali ke dorost be nazar mi-resid
 Hamed reasoning-INDEF that right to eye s eemed
 dar-morede mas'aleh kard vali natavanest ostadash
 about (the) matter did But could not his professor
 ra: moja:b konad
 ACCUS convince
 'Hamed made a reasoning which seemed to be correct about the problem but did not manage to convince his professor.'

c.
 Hamed charei dar morede mas'aleh andishid va
 Hamed solution-INDEF about (the) matter thought and
 esrar dasht a:n ra: amali konad
 insisted that ACCUS execute
 'Hamed thought of a solution about the problem and insisted to execute it.'

d.
 Hamed charei ke dorost be nazar miresid
 Hamed solution-INDEF that right to eye seemed
 dar morede mas'aleh andishid va esrar dasht a:n
 about (the) matter thought and insisted that
 ra: amali konad
 ACCUS execute
 'Hamed thought of a solution which seemed to be correct about the problem and insisted to execute it.'

34

a.
 Hossein eshtebahi dar morede hamsarash kard va a:n
 Hossein mistake-INDEF about his wife did and that
 eshtebah ba'ese jodayie a:n-ha: shod
 mistake cause (of) separation(of) them was
 'Hossein made a mistake about his wife and this caused of their separation.'

b.
 Hossein eshtebahi ke besia:r bozorg bud
 Hossein mistake-INDEF that very big was
 dar morede hamsarash kard va a:n eshtebah ba'ese
 about his wife did and that mistake cause (of)
 jodayie a:n-ha: shod

separation(of) them was
 ‘Hossein made a mistake which was so big about his wife and this caused of their separation.’

c.

Hossein	nokte'i	dar morede	hamsarash	fahmid	va
Hossein	point-INDEF	about	his wife	understood	and
ba'es shod	ehsasash	dar morede	u	taghir konad	
caused his	feeling	about	her	change	

‘Hossein found out of a point about his wife which cause his feelings of her to change.’

d.

Hossein	nokte'i	ke	besia:r	bozorg	bud	dar morede
Hossein	point-INDEF	that	very	big	was	about
hamsarash	fahmid	va	ba'es shod	ehsasash	dar morede	
his wife	understood	and	caused	his feeling	about	

u taghir konad
 her change
 ‘Hossein found out of a point which was very big about his wife which cause his feelings of her to change.’

35

a.

Nazanin	tasmimi	dar morede	xodash	gereft	va
Nazanin	decision-INDEF	about	herself	got	and
hameye	talashash	ra:	kard	ta	a:n
all (of)	her effort	ACCUS	did	so that	that
ra:	ejra konad				
ACCUS	accomplish				

‘Nazanin made a decision about herself and did her best to accomplish that.’

b.

Nazanin	tasmimi	ke	besia:r talx	bud	dar morede	xodash
Nazanin	decision-INDEF	that	very bitter	was	about	herself
gereft va	hameye	talashash	ra:	kard	ta:	a:n
got and	all (of)	her effort	ACCUS	did	so that	that
ra:	ejra konad					
ACCUS	accomplish					

‘Nazanin made a decision which was very bitter about herself and did her best to accomplish that.’

c.

Nazanin	vagheiati	dar morede	xodash	fahmid	va
Nazanin	truth-INDEF	about	herself	Understood	and
fekrash	hesabi	mashghul	shod		
her mind	so much	busy	got		

‘Nazanin found out of a truth about herself and her mind got so busy.’

d.

Nazanin	vagheiati	ke	besia:r	talx	bud	dar morede	xodash
Nazanin	truth-INDEF	that	very	bitter	was	about	herself

fahmid	va	fekrash	hesabi	mashghul	shod
Understood	and	her mind	so much	busy	got

‘Nazanin found out of a truth which was very bitter about herself and her mind got so busy.’

36

a.

Mehdi E'terafi		dar	dadgah	kard	va	be
Mehdi confession-INDEF		at	(the) court	did	and	to
habs-e	abad		mahkum	shod		
imprisonment (of)	for ever		condemned	got		

‘Mehdi made a confession in the court and got condemned of imprisonment for ever.’

b.

Mehdi E'terafi		ke	be zarare	xodash	tamam shod	dar
Mehdi confession-INDEF		that	against	himself	was ended	at
dadgah	kard	va	be	habs-e	abad	
(the) court	did	and	to	imprisonment (of)	for ever	
mahkum	shod					
condemned	got					

‘Mehdi made a confession which ended up against himself in the court and got condemned of imprisonment for ever.’

c.

Mehdi shahadat-namei		dar	dadgah	nevesht	va	be
Mehdi testimony-INDEF		at	(the) court	wrote	and	to
habs-e	abad		mahkum	shod		
imprisonment (of)	for ever		condemned	got		

‘Mehdi wrote a testimony in the court and got condemned of imprisonment for ever.’

d.

Mehdi shahadat-namei		ke	be zarare	xodash	tamam shod	dar
Mehdi testimony-INDEF		that	against	himself	ended	at
dadgah	nevesht	va	be	habs-e	abad	
(the) court	wrote	and	to	imprisonment (of)	for ever	
mahkum	shod					
condemned	got					

‘Mehdi wrote a testimony which ended up against himself in the court and got condemned of imprisonment for ever.’

Appendix B. Experimental stimuli for the second self-paced reading and the second eye-tracking studies

1.

a.

Maryam	a:rezouyi	bara:ye	man	kard	ke	xeili	zud
Maryam	wish-INDEF	for	1.S	do-PST	which	very	soon
bara:vardeh	shod						
fulfilled	became						

‘Maryam wished something for me which very soon became fulfilled.’

b.

Maryam	a:rezouyi	bara:ye	baraye khahare	doost-eman	kard
Maryam	wish-INDEF	for	sister (of)	friend (of)	me
ke	xeili	zud	bara:vardeh	shod	do-
PST	which	very	soon	fulfilled	became

‘Maryam wished something for sister of my friend which very soon became fulfilled.’

c.

Maryam	qaza-i:	bara:ye	man	poxt	ke	xeili	xosh-
Maryam	food-INDEF	for		1.S	cook-PST	which	very
mazeh bud							
delicious	was						

‘Maryam cooked a food for me which was very delicious.’

d.

Maryam	qaza-i:	bara:ye	khahare	doost-	man
Maryam	food-INDEF	for	sister (of)	friend (of)	me
poxt	ke	xeili	xosh-mazeh	bud	
cook-PST	which	very	delicious	was	

‘Maryam cooked a food for sister of my friend which was very delicious.’

2.

a.

Ali	a:hangi	bara:ye	man	zad	ke	mara:	be
Ali	music-INDEF	for	1.S	perform-PST	which	1.S-ACCUS	to
sa:lha:ie	java:ni	bord					
years	adolescent	took					

‘Ali performed a music for me which took me to adolescent years.’

b.

Ali	a:hangi	bara:ye	jashne	tavallode	man
Ali	music-INDEF	for	celebration (of)	birthday (of)	me
zad	and	mara: be	sa:lha:ie	java:ni	bord
perform-PST	which	1.S	to	years	adolescent
					took

‘Ali performed a music for my birthday celebration which took me to adolescent years.’

c.

Ali	shokolati	baraye	man	xarid	ke	mazze'ash
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Ali chokolate-INDEF for me bought which its-flavor
 harf nadasht
 word didnot-have

‘Ali bought a chocolate for me whose taste was perfect.’

d.

Ali shokolati baraye jashne tavallode man
 Ali chokolate-INDEF for celebration (of) birthday (of) me
 xarid ke mazze'ash harf nadasht
 bought which its-flavor word didnot-have

‘Ali bought a chocolate for my birthday celebration whose taste was perfect.’

3.

a.

Madaram do'ayi baraye man kard ta hamishe
 My-mother prayer-INDEF for me did so that always
 movaffagh basham
 successful am

‘My mother said a prayer for me so that I become successful.’

b.

Madaram do'ayi baraye dokhtar-khaleye doost-eman kard
 My-mother prayer-INDEF for cousin (of) friend (of) me did
 ta hamishe movaffagh basham
 so that always successful am

‘My mother said a prayer for my friend’s cousin so that I become successful.’

c.

madaram Lebasi baraye man duxt ta zemestan
 My-mother dress-INDEF for me sewed so-that (in) winter
 a:n ra: bepusham
 that ACCUS wear(i)

‘My mother sewed a dress for me so that I wear that in winter.’

d.

madaram Lebasi baraye dokhtar-khaleye doost-e man
 My-mother dress-INDEF for cousin (of) friend (of) me
 duxt ta zemestan a:n ra: bepusham
 sewed so-that (in) winter that ACCUS wear(i)

‘My mother sewed a dress for my friend’s cousin so that I wear that in winter.’

4.

a.

Hamid taghazayi az Mina kard va montazere javab
 Hamid request-INDEF from Mina did and wait (for) reply
 shod
 became

‘Hamid requested something from Mina and waited for reply.’

b.

Hamid taghazayi az Khaharzade-e hamsaye-ye Mina kard
 Hamid request-INDEF from cousin (of) neighbor (of) Mina did

va montazere javab shod
and wait (for) reply did

‘Hamid requested something from cousin of Mina’s neighbor and waited for reply.’

c.

Hamid javabi az Mina shenid va shokkeh
Hamid reply-INDEF from Mina heard and shocked
shod
got

‘Hamid heard a reply from Mina and got shocked.’

d.

Hamid javabi az Khaharzade-e hamsaye-ye Mina shenid
Hamid reply-INDEF from cousin (of) neighbor (of) Mina heard
va shokkeh shod
and shocked got

‘Hamid heard a reply from cousin of Mina’s neighbor and got shocked.’

5

a.

Hassan shekayati az hamsaye'ash kard amma
Hassan complaint-INDEF from his-neighbor did but
ba'd az u ozr-xahi kard
then from him apology did

‘Hassan made a complaint which was not logical at all from his neighbor but then apologized from him.’

b.

Hassan shekayati az hamseye-ye mahall-e ghadimash
Hassan complaint-INDEF from neighbor (of) neighborhood (of) old time
kard amma ba'd az u ozr-xahi kard
did but then from him apology did

‘Hassan made a complaint which was not logical at all from his neighbor from his old-time neighborhood but then apologized from him.’

c.

Hassan dastani az hamsaye'ash shenid va
Hassan story-INDEF from his-neighbor heard and
nemidanest bayad a:n ra: bavar-konad ya na
didnot know (if) must that ACCUS believe or not

‘Hassan heard a story which was not logical at all from his neighbour and didn’t know if she should believe it or not.’

d.

Hassan dastani az hamseye-ye mahall-e ghadimash
Hassan story-INDEF from neighbor (of) neighborhood (of) old time
shenid va nemidanest bayad a:n ra: bavar-konad ya na
heard and didn't know (if) must that ACCUS believe or not

‘Hassan heard a story which was not logical at all from his neighbour from his old-time neighborhood and didn’t know if she should believe it or not.’

6

a.
 xabarnegar bardashti az harfe man kard
 The journalist impression-INDEF from word (of) me did
 dar hali ke Dorost nabud
 while Correct was not
 'The journalist got the impression he liked from my words while it was not correct.'

b.
 xabarnegar bardashti az harfe mard-e bi-khaneman
 The journalist impression-INDEF from word (of) man homeless
 kard dar hali ke Dorost nabud
 did while Correctwas not
 'The journalist got the impression he liked from words of the homeless man while it was not correct.'

c.
 xabarnegar gozareshi ke xodash delash mixast az
 The journalist report-INDEF that himselfhis-heart wanted from
 harfe man nevesht dar-hali-ke dorost nabud
 word (of) me wrote while correct was not
 'The journalist wrote a report which he liked from my words while it was not correct.'

d.
 xabarnegar gozareshi ke xodash delash mixast az
 The journalist report-INDEF that Himself his-heart wanted from
 harfe mard-e bi-khaneman nevesht dar-hali-ke Dorost nabud
 word (of) man homeless wrote while Correct wasnot
 'The journalist wrote a report which he liked from words of the homeless man while it was not correct.'

7.

a.
 Sepideh tahlili az maghaleh kard va a:n
 Sepideh analysis-INDEF from (the) article did and that
 ra: dar conferans era'eh-dad
 ACCUS in conference presented
 'Sepideh made an analysis from the article and presented it in the conference.'

b.
 Sepideh tahlili az maghale-ye akhir-e Chomskey kard
 Sepideh analysis-INDEF from paper (of) latest Chomskey did
 va a:n ra: dar conferans era'eh-dad
 and that ACCUS in conference presented
 'Sepideh made an analysis from the latest paper of Chomskey and presented it in the conference.'

c.
 Sepideh Naghdi az maghaleh xa:nd va dar
 Sepideh criticism-INDEF from (the) article read and in
 soxanranie xod be a:n eshare kard

presentation (of) himself to that pointed
 ‘Sepideh read a criticism from the article and pointed to that in her presentation.’

d.

Sepideh Naghdi az maghale-ye akhir-e Chomskey xa:nd
 Sepideh criticism-INDEF from paper (of) latest Chomskey read
 va dar soxanranie xod be a:n eshare kard
 and in presentation (of) himself to that pointed
 ‘Sepideh read a criticism from the latest paper of Chomskey and pointed to that in her presentation.’

8.

a.

Sara Entezari az man dasht va man nemitavanest a:n
 Sara expectation-INDEF from me had and I could-not that
 ra: baravardeh-konam
 ACCUS meet

‘Sara had an expectation from me and I could not meet that.’

b.

Sara Entezari az pedar-e varshekaste-ye ma dasht
 Sara expectation-INDEF from father bankrupted (of)us had
 va man nemitavanest a:n ra: baravardeh-konam
 and I could-not that ACCUS meet

‘Sara had an expectation from our bankrupted father and I could not meet that.’

c.

Sara Darxa:sti az man dasht va man nemitavanestam
 Sara request-INDEF from me had and I couldnot
 a:n ra: baravardeh konam
 that ACCUS meet

‘Sara had a request from me and I could not fulfill that.’

d.

Sara Darxa:sti az pedar-evarshekaste-yema dasht va
 Sara request-INDEF from father bankrupted (of)us had and
 nemitavanest a:n ra: baravardeh konam
 couldnot that ACCUS meet

‘Sara had a request from our bankrupted father and he could not fulfill that.’

9.

a.

Hamkaram sahmi az sherkat bord dar hali ke man
 My colleague share-INDEF from (the) company won while I
 bishtar az u baraye sherkat zahmat-keshideh-budam
 more than him for (the)company had toiled
 ‘My colleague won a share from the company while I had toiled more than him for the company.’

b.

Hamkaram sahmi az sherkat-e tejari bazargani bord

My colleague share-INDEF from (the) company trading commercial won
dar hali ke man bishtar az oo
while I more than him
for (the)company had toiled
baraye sherkat zahmat-keshideh-budam
‘My colleague won a share from the commercial trading company while I had toiled
more than him for the company.’

c.

Hamkaram enteghadi az sherkat dasht amma
My colleague criticism-INDEF from (the) company had but
natavanest heiat-modireh ra: motegha'ed konad
could not board-of-directors ACCUS persuade
‘My colleague had a criticism from the company but could not persuade the board of
directors.’

d.

Hamkaram enteghadi az sherkat-e tejari bazargani
My colleague criticism-INDEF from (the) company trading commercial
dasht amma natavanest heiat-modireh ra: motegha'ed konad
had but could not board-of-directors ACCUS persuade
‘My colleague had a criticism from the commercial trading company but could not
persuade the board of directors.’

10

a.

Man xa:heshi az Mahsa : kardamamma u a:n
I request-INDEF from Mahsa did-1.S But she that
ra: rad-kard
ACCUS rejected
‘I requested something from Mahsa but she rejected that.’

b.

Man xa:heshi az hamkelasi-e baradar-e Mahsa : kardam
I request-INDEF from classmate (of) brother (of) Mahsa did-1.S
amma u a:n ra: rad-kard
but she that ACCUS rejected
‘I requested something from the classmate of Mahsa’s brother but she rejected that.’

c.

man Puli az Mahsa : gereftam Chon
I money-INDEF from Mahsa got because
kifam ra: dar xa:neh ja-gozashte-budam
my-purse ACCUS at home had-left(i)
‘I got some money from Mahsa because I had left my purse at home.’

d.

man Puli az hamkelasi-e baradar-e Mahsa :
I money-INDEF from classmate (of) brother (of) Mahsa
gereftam Chon kifam ra: dar xa:neh ja-gozashte-budam
got because my-purse ACCUS at home had-left(i)

‘I got some money from the classmate of Mahsa’s brother because I had left my purse at home.’

11

a.

Elham	atri	ra:	be	lebasash	zad	va
Elham	perfume-INDEF	ACCUS	to	her dress	hit	and
tavajjohe	hame	ra:		jalb kard		
attention (of)	all	ACCUS	drew			

‘Elham used a perfume on her dress and had attracted everyone’s attention.’

b.

Elham	atri	ra:	be	lebas-e ghermez-e		
Elham	perfume-INDEF	ACCUS	to	her dress	red	
jadidash	zad	va	tavajjohe	hame	ra:	jalb kard
new	hit	and	attention (of)	all	ACCUS	drew

‘Elham used a perfume on her new red dress and had attracted everyone’s attention.’

c.

Elham	sanjaghi	ra:	be	lebasash	a:vixt	va
Elham	clips-INDEF	ACCUS	to	her-dress	hang	and
tavajjohe	hame	ra:		jalb kard		
attention (of)	all	ACCUS	drew			

‘Elham hanged a clips to her dress and attracted everyone’s attention.’

d.

Elham	sanjaghi	ra:	be	lebas-e ghermez-e	jadidash	
Elham	clips-INDEF	ACCUS	to	her dress	red	new
a:vixt	va	tavajjohe	hame	ra:	jalb kard	
hang	and	attention (of)	all	ACCUS	drew	

‘Elham hanged a clips to her new red dress and attracted everyone’s attention.’

12

a.

Mohsen	ettehami	be	man	zad	amma	natavanest
Mohsen	accusation-INDEF	to	me	hit	but	could not
a:n	ra:					
that	ACCUS	sabet konad				
		prove				

‘Mohsen accused me of something but did not manage to prove it.’

b.

Mohsen	ettehami	be	khaharzade-ye ham-otaghi-e	man
Mohsen	accusation-INDEF	to	niece/nephew roommate	(of) me
zad	amma	natavanest	a:n	ra:
hit	but			sabet konad
		could not	that	ACCUS
				prove

‘Mohsen accused my roommate’s niece/nephew of something but did not manage to prove it.’

c.

Mohsen	ra:zi	be	Man	goft	va	hesabi
Mohsen	secret-INDEF	to	Me	said	and	so much

mara: dar fekr foru-bord
 me-ACCUS in thought Drowned
 'Mohsen told a secret to me and made me get drowned in my thoughts.'

d.

Mohsen ra:zi be khaharzade-ye ham-otaghi-e man goft
 Mohsen secret-INDEF to niece/nephew roommate (of) me said
 va hesabi mara: dar fekr foru-bord
 and so much me-ACCUS in thought Drowned
 'Mohsen told a secret to my roommate's niece/nephew and made me get drowned in my thoughts.'

13

a.

Reza labxandi be Man zad va man hargez a:n ra:
 Reza smile-INDEF to Me hit and I never that ACCUS
 faramush nemikonam
 forget

'Reza smiled at me and I will never forget that.'

b.

Reza labxandi be pedar-ebimar-e man zad va man hargez
 Reza smile-INDEF to father ill me hit and I never
 a:n ra: faramush nemikonam
 that ACCUS forget

'Reza smiled at my sick father and I will never forget that.'

c.

Reza baghi be man foruxt va az in shahr raft
 Reza garden-INDEF to me sold a:nd from this city went
 'Reza sold a garden which was full of comfort to me and left this city.'

d.

Reza baghi be pedar-ebimar-e man foruxt va az
 Reza garden-INDEF to father ill me sold a:nd from
 in shahr raft
 this city went

'Reza sold a garden which was full of comfort to my sick father and left this city.'

14

a.

Mojgan tohmati be man zad va ba'es shod
 Mojgan insult-INDEF to me hit and caused
 ba u ghat'e ra:beteh konam
 with her cut-relation do.1.S

'Mojgan insulted me and caused me to cut my relations to her.'

b.

Mojgan tohmati be nazdiktarin doost-e man zad va
 Mojgan insult-INDEF to (the) closest friend (of) me hit and
 ba'es shod ba u ghat'e ra:beteh konam
 caused with her cut-relation do (i)

‘Mojgan insulted my closest friend and caused me to cut my relations to her.’

c.

Mojgan	hedyei	be	man	dad	va	man	hesabi
Mojgan	gift-INDEF	to	me	gave	and	I	so much
zogh-zadeh	shodam						
excited	got.1.S						

‘Mojgan gave a gift to me and I got so excited.’

d.

Mojgan	hedyei	be	nazdiktarin	doost-e	man	dad
Mojgan	gift-INDEF	to	(the) closest	friend (of)	me	gave
va	man	hesabi	zogh-zadeh	shodam		
and	I	so much	excited	got		

‘Mojgan gave a gift to my closest friend and I got so excited.’

15

a.

hamsaram	zarbei	be	zendegiam	zad	va	zendegie
My spouse	damage-INDEF	to	my life	hit	and	life-of
marā:	az	in	ru	be	a:n	ru
me- ACCUS	from	this	face	to	that	face
						did

‘My spouse made a damage to my life and changed my life drastically.’

b.

hamsaram	zarbei	be	zendegi-e	kesalat-bar-e	man	zad
My spouse	damage-INDEF	to	life	boring me		hit
va	zendegie	marā:	az	in	ru	be
and	life (of)	me-ACCUS	from	this	face	a:n
					to	that
					face	face
						did

‘My spouse made a damage to my boring life and changed my life drastically.’

c.

Hamsaram	shadi	be	zendegiam	avard	va
My spouse	happiness-INDEF	to	my life	brought	and
zendegie	marā:	az	in	ru	be
life (of)	me- ACCUS	from	this	face	aan
					ru
					to
					that
					face
					did

‘My spouse brought a happiness that I did not expect at all to my life and change my life drastically.’

d.

Hamsaram	shadi	be	zendegi-e	kesalat-bar-e	man
My spouse	happiness-INDEF	to	life	boring	me
avard	va	zendegie	marā:	az	in
brought and	life (of)	me-ACCUS	from	this	ru
					be
					aan
					ru
					to
					that
					face
					face
					did

‘My spouse brought a happiness that I did not expect at all to my boring life and change my life drastically.’

16

a.

Farzad harfi	be	man	Zad	va	az	otagh	xarej shod
Farzad word-INDEF	to	me	Hit	and	from	(the) room	went out

‘Farzad said something to me and left the room.’

b.

Farzad	harfi	be	ostad-e	zaban-e	man	zad	va	az
Farzad	word-INDEF	to	professor (of)	language	me	Hit	and	from
otagh	xarej	shod						
(the) room	went out							

‘Farzad said something to my language professor and left the room.’

c.

Farzad	ketabi	be	man	dad	amma	hanuz
Farzad	book-INDEF	to	me	gave	but	still
forsat	nakardam	a:n	ra:	bexanam		
chance	didn't have	that	ACCUS	read		

‘Farzad gave a book to me but I still haven’t had the chance to read it.’

d.

Farzad	ketabi	be	ostad-e	zaban-e	man
Farzad	book-INDEF	to	professor (of)	language	me
dad	amma	hanuz	forsat	nakardam	a:n
gave	but	still	chance	didn't have	that
					ACCUS
					read

‘Farzad gave a book to my language professor but I still haven’t had the chance to read it.’

17

a.

moallemam	tosieii	be	man	kard	va	man
My teacher	recommendation-INDEF	to	me	did	and	I
say kardam	a:n	ra:	be kar	bebandam		
tried	that	ACCUS	put into	practice		

‘My teacher gave a recommendation to me and I tried to put it into practice.’

b.

moallemam	tosieii	be	shagerdan-e	sal-e	akhar
My teacher	recommendation-INDEF	to	students (of)	year	last
kard va	man	say kardam	a:n	ra:	be kar bebandam
did and	I	tried	that	ACCUS	put into practice

‘My teacher gave a recommendation to last year students and I tried to put it into practice.’

c.

moallemam	darsi	be	man	amuxt	va	man	a:n
My teacher	lesson-INDEF to	me	taught	and	I	that	
ra:	hargez	faramush-nemikonam					
ACCUS	never	forget-do not					

‘My teacher taught a lesson to me and I never forget that.’

d.

moallemam	darsi	be	shagerdan-e	sal-e	akhar	amuxt	va
My teacher	lesson-INDEF	to	students (of)	year	last	taught	and
a:n	ra:	hargez	faramush-nemikonand				
that	ACCUS	never	forget				

‘My teacher taught a lesson to last year students and they never forget that.’

18

- a.
Kourosh nasihati be man Kard va man a:n
Kourosh advice-INDEF to me did and I that
ra: gush dadam
ACCUS listened
'Kourosh gave an advice to me and I listened to that.'
- b.
Kourosh nasihati be baradar-e afsorde-ye man
Kourosh advice-INDEF to brother depressed me
kard va man a:n ra: gush dadam
did and I that ACCUS listened
'Kourosh gave an advice to my depressed brother and I listened to that.'
- c.
Kourosh noktei be man fahmand va man taze
Kourosh point-INDEF to me made across and I just
haghighat ra: fahmidam
(the) truth ACCUS understood
'Kourush explained a point to me and I just understood that truth.'
- d.
Kourosh noktei be baradar-e afsorde-ye man
Kourosh point-INDEF to brother depressed me
fahmand va man taze haghighat ra: fahmidam
made across and I just (the) truth ACCUS understood
'Kourush explained a point to my depressed brother and I just understood that truth.'

19

- a.
Shabnam pishnahadi be man kard va man a:n
Shabnam suggestion-INDEF to me Did and I that
ra: ghabul kardam
ACCUS accepted
'Shabnam made a suggestion to me and I accepted that.'
- b.
Shabnam pishnahadi be pesarkhale-ye doost-e man kard
Shabnam suggestion-INDEF to cousin (of) friend (of) me did
va man a:n ra: ghabul kardam
and I that ACCUS accepted
'Shabnam made a suggestion to my friend's cousin and I accepted that.'
- c.
Shabnam tablo'i be man baxshid va man a:n
Shabnam picture-INDEF to me spared and I that
ra: be divar zadam
ACCUS to (the) wall attached (i)
'Shabnam spared a picture to me and I attached that to the wall.'
- d.

Shabnam	tablo'i	be	pesarkhale-ye	doost-e	man
Shabnam	picture-INDEF	to	cousin (of)	friend (of)	me
baxshid	va man a:n	ra:	be	divar	zadam
spared	and I that	ACCUS	to	(the) wall	attached (i)

'Shabnam spared a picture to my friend's cousin and I attached that to the wall.'

20

a.

Behnam	ra:hnamayi	ra:	be	man	kard	va	ba'es-shod
Behnam	guidance-INDEF	ACCUS	to	me	did	and	caused
betavanam	tasmimam	ra:	begiram				
(that)	Can (i) my decision	ACCUS	make (i)				

'Behnam gave me a guidance and that caused me to be able to make my decision.'

b.

Behnam	ra:hnamayi	ra:	be	daneshjooye	momtaz-e
Behnam	guidance-INDEF	ACCUS	to	student	merit
khod kard	va ba'es shod	betavanam	tasmimam	ra:	begiram
(of) his	did and caused	can (i)	my decision	ACCUS	make (i)

'Behnam gave his merit student a guidance that caused him to be able to make his decision.'

c.

Behnam	maghale'ii	ra:	be	Man	dad	va	hesabi
Behnam	article-INDEF	ACCUS	to	Me	gave	and	so much
karam	ra:	jolo-andaxt	.				
my work	ACCUS	progressed					

'Behnam gave an article to me and progressed my work a lot.'

d.

Behnam	maghale'ii	ra:	be	daneshjooye	momtaz-e	khod
Behnam	article-INDEF	ACCUS	to	student	merit	(of) his
dad va	hesabi	karam	ra:	jolo-andaxt		
gave and	so much	my work	ACCUS	progressed		

'Behnam gave an article to his merit student and progressed his work a lot.'

21

a.

hamsaye'am	tazakkori	be	dustamdad	va	az	u
My neighbor	point-INDEF	to	my friend	gave	and	from him/her
xast	kamtar sigar-bekeshad					
wanted	less smoke					

'My neighbour gave a point to my friends and asked him/her to smoke less.'

b.

hamsaye'am	tazakkori	be	pedar-esalkhorde-ye	dustamdad	va
My neighbor	point-INDEF	to	father old	my friend	gave and
az u	xast	kamtar sigar-bekeshad			
from him/her	wanted less	smoke			

'My neighbour gave a point to my friend's old father and asked him/her to smoke less.'

c.

Hamsaye'am davayi be dustam resand va jane
My-neighbord medication-INDEF to my-friend fetched and life (of)
u ra: nejat-dad
him/her ACCUS saved

'My neighbour fetched a medication which was completely timely for my friend and save his/her life.'

d.

Hamsaye'am davayi be pedar-esalkhorde-ye dustam resand
My-neighbord medication-INDEF to father old my friend fetched
va jane u ra: nejat-dad
and life (of) him/her ACCUS saved

'My neighbour fetched a medication which was completely timely for my friend's old father and save his/her life.'

22

a.

Nima sefareshi be man Kard va az man xast
Nima request-INDEF to me Did and from me wanted
ke moraghebe xaharash Basham
that looking after his sister am (i)

'Nima requested something which was very life-saving from me and asked me to take care of his sister.'

b.

Nima sefareshi be shohar-e khahar-e bozorgash kard
Nima request-INDEF to husband (of) sister older did
va az man xast ke moraghebe xaharash basham
and from me wanted that looking after his sister am (i)

'Nima requested something which was very life-saving from his older sister's husband and asked him to take care of his sister.'

c.

Nima amanati be man sepord va az man xast
Nima borrowing-INDEF to me gave and from me wanted
ta a:n ra: be daste xaharash beresanam
so that that ACCUS to hand (of) his sister take (i)

'Nima gave a borrowing to me and asked me to take it to his sister.'

d.

Nima amanati be shohar-e khahar-e bozorgash
Nima borrowing-INDEF to husband (of) sister older
sepord va az man xast ta a:n ra:
gave and from me wanted so that that ACCUS

Be daste xaharash beresanam

To hand (of) his sister take (i)

'Nima gave a borrowing to his older sister's husband and asked to take it to his sister.'

23

a.
 adam-roba-ha hoshdari be man dadand va az
 The kidnappers warning-INDEF to me gave and from
 man xastand ta pul ra: harche zudtar
 me wanted to (the) money ACCUS whatever sooner
 amadeh-konam vagarna pesaram ra: mikoshand
 prepare(i) otherwise my son ACCUS kill(they)
 ‘The kidnappers gave a warning to me and asked me to prepare the money as soon as possible or else they will kill my son.’

b.
 adam-roba-ha hoshdari be khanevade-ye koodak-e
 The kidnappers warning-INDEF to the family (of) baby
 roboodeh-shode dadand va az man xastand ta
 kidnapped gave and from me wanted to
 pul ra: harche zudtar amadeh-konam vagarna
 (the) money ACCUS whatever sooner prepare(i) otherwise
 pesaram ra: mikoshand
 my son ACCUS kill(they)
 ‘The kidnappers gave a warning to the family of the kidnapped baby and asked them to prepare the money as soon as possible or else they will kill thier son.’

c.
 adam-roba-ha extari be man ferestadand va az man
 The kidnappers alarm-INDEF to me sent and from me
 xastand ta pul ra: harche zudtar
 wanted to (the) money ACCUS whatever sooner
 amadeh-konam vagarna pesaram ra: mikoshand
 prepare(i) otherwise my son ACCUS kill(they)
 ‘The kidnappers sent an alarm to me and asked me to prepare the money as soon as possible or else they will kill my son.’

d.
 adam-roba-ha extari be khanevade-ye koodak-eroboodeh-shode
 The kidnappers alarm-INDEF to the family (of) baby kidnapped
 ferestadand va az man xastand ta pul
 sent and from me wanted to (the) money
 ra: harche zudtar amadeh-konam vagarna
 ACCUS whatever sooner prepare(i) otherwise
 pesaram ra: mikoshand
 my son ACCUS kill(they)
 ‘The kidnappers sent an alarm to the family of the kidnapped baby and asked them to prepare the money as soon as possible or else they will kill their son.’

24

a.
 Farhad gholi be man dad va
 Farhad promise-INDEF to me gave and

digar xialam ra:hat shod
 from that time my soul got relaxed
 'Farhad promised something to me and made me relaxed.'

b.

Farhad gholi be khahar-e mehraban-e man dad
 Farhad promise-INDEF to sister kind me dave
 va digar xialam ra:hat shod
 and from that time my soul got relaxed
 'Farhad promised something to her kind sister and made her relaxed.'

c.

Farhad xabari be man dad va mara: az
 Farhad news-INDEF to me gave and me-ACCUS from
 negarani dar-avard
 worry took-out
 'Farhad gave a piece of news which was very promising to me and helped not worry anymore.'

d.

Farhad xabari be khahar-e mehraban-e man dad va
 Farhad news-INDEF to sister kind me gave and
 mara: az negarani dar-avard
 me-ACCUS from worry took-out
 'Farhad gave a piece of news which was very promising to my kind sister and helped her not worry anymore.'

25

a.

Mitra doruqi be man goft amma ba'd dastash ru shod
 Mitra lie-INDEF to me told but then her hands got caught
 'Mitra told a lie to me but then the truth was discovered.'

b.

Mitra doruqi be dokhtar-e koochak-e man goft amma ba'd
 Mitra lie-INDEF to daughter little me told but then
 dastashru shod
 her hands got caught
 'Mitra told a lie to my little daughter but then the truth was discovered.'

c.

Mitra arusaki be man dad va man a:n ra: az
 Mitra doll-INDEF to me gave and I that ACCUS from
 xodam joda nemikardam
 my selfdidn't separate
 'Mitra gave a doll which seemed real to me and I used to never separate it from me.'

d.

Mitra arusaki be dokhtar-e koochak-e man dad va man
 Mitra doll-INDEF to daughter little me gave and I
 a:n ra: az xodam joda nemikardam
 that ACCUS from my selfdidn't separate

‘Mitra gave a doll which seemed real to my little daughter and she used to never separate it from herself.’

26

a.

Nilufar pishrafti	dar	madreseh	kard	va	az	moallemash
Nilufar progress-INDEF	at	school	did	and	from	her teacher
jayezeh gereft						
prize got						

‘Nilufar had a progress which she had promised in school and got a prize from her teacher.’

b.

Nilufar pishrafti	dar	madrese-ye	dolati-e	Ma'refat	kard
Nilufar progress-INDEF	at	school	governmental	Ma'refat	did
va az moallemash	jayezeh	gereft			
and from her teacher	prize	got			

‘Nilufar had a progress which she had promised in Ma'refat public school and got a prize from her teacher.’

c.

Nilufar deklamei	dar	madrese	xand	va	jayezeye
Nilufar composition-INDEF	at	school	read	and	prize (of)
behtarin deklameye	mantagheh	ra:	gereft		
best composition(of) region	ACCUS	got			

‘Nilufar read the composition she had promised at school and got the prize of the best composition of the region.’

d.

Nilufar deklamei	dar	madrese-ye	dolati-e	Ma'refat	xand
Nilufar composition-INDEF	at	school	governmental	Ma'refat	read
va jayezeye behtarin	deklameye	mantagheh	ra:	gereft	
and prize (of) best	composition(of) region	ACCUS	got		

‘Nilufar read the composition she had promised at Ma'refat public school and got the prize of the best composition of the region.’

27

a.

Majid lotfi	be	man	kard	va	man	hamishe	be	u
Majid favor-INDEF	to	Me	did	and	I	always	to	him
madiunam								
owe (i)								

‘Majid did a favor to me and I always owe him.’

b.

Majid lotfi	be	baradar-e	javan-eman	kard	va	man
Majid favor-INDEF	to	brother	young me	did	and	I
hamishe be u	madiunam					
always to him	owe (i)					

‘Majid did a favor to my young brother and I always owe him.’

c.

Majid nasezayi be man goft va man ta omr daram
 Majid swearword-INDEF to Me said and I till alive am
 faramush nemikonam
 forget do not

‘Majid said a swear word to me and I will never forget him till I am alive.’

d.

Majid nasezayi be baradar-e javan-eman goft va man
 Majid swearword-INDEF to brother young me said and I
 ta omr daram faramush nemikonam
 till alive am forget do not

‘Majid said a swear word to my young brother and I will never forget him till I am alive.’

28

a.

ostad sohbat ba shagerdash kard va u
 (The) professor word-INDEF to his/her student did and him/her
 ra: motegha'ed kard ke tasmimash ra: avaz konad
 ACCUS persuaded that his/her decision ACCUS change
 ‘The professor said something to his/her students and he/she got persuaded to change his/her decision.’

b.

ostad sohbat ba shagerd-e ghadimi-e khod
 (The) professor word-INDEF to student old (of) him/her self
 kard va u ra: motegha'ed kard ke tasmimash
 did and him/her ACCUS persuaded that his/her decision
 ra: avaz konad
 ACCUS change

‘The professor said something to his/her old student and he/she got persuaded to change his/her decision.’

c.

Ostad ghat'ei ba shagerdash navaxt va jamiat
 (the) professor piece-INDEF with his/her student played and (the) crowd
 hesabi tashvigheshan kardan
 so much clapped (for them)

‘The professor played a piece with his/her students which was very impressive and the crowd clapped a lot for him/her.’

d.

Ostad ghat'ei ba shagerd-e ghadimi-e
 (the) professor piece-INDEF with student old(of)
 khod navaxt va jamiat hesabi tashvigheshan kardan
 him/her self played and (the) crowd so much clapped (for them)

‘The professor played a piece with his/her old student which was very impressive and the crowd clapped a lot for him/her.’

29

a.

Sina gharari ba Neda gozasht amma u sare
 Sina appointment-INDEF with Neda put but she to
 gharar nayamad
 (the) appointment did not come

‘Sina made an appointment with Neda but she did not show up.’

b.

Sina gharari ba baradar-e doost-e Neda gozasht
 Sina appointment-INDEF with brother (of) friend (of) Neda put
 amma u sare gharar nayamad
 but she to (the) appointment did not come

‘Sina made an appointment with brother of Neda’s friend but she did not show up.’

c.

Sina safari ba Neda raft va be a:nha: xeili
 Sina travel-INDEF with Neda went and to them very much
 xosh gozasht
 fun was

‘Sina went on a trip with Neda and they had lots of fun.’

d.

Sina safari ba baradar-e doost-e Neda raft va be
 Sina travel-INDEF with brother (of) friend (of) Neda went and to
 a:nha: xeili xosh gozasht
 them very much fun was

‘Sina went on a trip with brother of Neda’s friend and they had lots of fun.’

30

a.

Man hadsi dar morede Setareh zadam va xeili dir
 I guess-INDEF about Setareh hit (i) and very late
 motevajjeh shodam ke hadsam dorost nabudeh ast
 realize did that my guess correct was not

‘I guessed something about Setareh and figured out very late that it was not correct.’

b.

Man hadsi dar morede gozashte-ye mobham-e Setareh zadam
 I guess-INDEF about (the) past ambiguous Setareh hit (i)
 va xeili dir motevajjeh shodam ke hadsam dorost
 and very late realize did that my guess correct
 nabudeh ast

was not

‘I guessed something about Setareh’s ambiguous past and figured out very late that it was not correct.’

c.

Man shaye’ei dar morede Setareh shenidam va xeili asabani
 I rumor-INDEF about Setareh heard (i) and very angry
 shodam

was (i)

‘I heard a rumor about Setareh and got very angry.’

d.

man	shaye'ei	dar morede	gozashte-ye	mobham-e	Setareh
I	rumor-INDEF	about	(the) past	ambiguous	Setareh
shenidam	va	xeili	asabani	shodam	
heard (i)	and	very	angry	was (i)	

‘I heard a rumor about Setareh’s ambiguous past and got very angry.’

31

a.

Pejman	qezavati	darmorede	man	kard	amma	motevajehe
Pejman	judgement-INDEF	about	me	did	but	realize
eshtebahash	shod					
his mistake	got					

‘Pejman made a judgement about me but realized his mistake.’

b.

Pejman	qezavati	darmorede	khahar-e	koochehtar-e	man
Pejman	judgement-INDEF	about	sister	younger	me
kard	amma	motevajehe	eshtebahash	shod	
did	but	realize	his mistake	got	

‘Pejman made a judgement about my younger sister but realized his mistake.’

c.

Pejman	xabari	darmorede	man	shenid	amma	a:n	ra:
Pejman	news-INDEF	about	me	heard	but	that	ACCUS
bavar nakard							
didnot believe							

‘Pejman heard a piece of news about me but he did not believe it.’

d.

Pejman	xabari	darmorede	khahar-e	koochehtar-e	man	shenid
Pejman	news-INDEF	about	sister	younger	me	heard
amma	a:n	ra:	bavar nakard			
but	that	ACCUS	didnot believe			

‘Pejman heard a piece of news about my younger sister but he did not believe it.’

32

a.

Kaveh hessi		darmorede	Parisa	mikard va	man	in
Kaveh	feeling-INDEF	about	Parisa	did	and	I
ra:	az	negahash	mixandam			this
ACCUS	from	his look	read			

‘Kaveh had a feeling about Parisa and I could read this his look.’

b.

Kaveh hessi		dar morede	khahar-e	bozorgtar-e	Parisa
mikard va	man	in	ra:	az	negahash
Kaveh	feeling-INDEF	about	sister	older	mixandam
did	and	I	this	ACCUS	from
					his look
					read

‘Kaveh had a feeling about Parisa’s older sister and I could read this his look.’

c.

Kaveh	vageiati		dar morede	Parisa	Fahmid	amma	be
Kaveh	truth-INDEF		about	Parisa	understood	but	to
ruye	xodash		nayavard				
face	(of)herself		didnot	bring			

‘Kaveh found out a truth about Parisa but he did not mention it.’

d.

Kaveh	vageiati		dar morede	khahar-e	bozorgtar-e	Parisa
Kaveh	truth-INDEF		about	sister	older	Parisa
Fahmid	amma	be	ruye	xodash	nayavard	
understood	but	to	face (of)	herself	didnot	bring

‘Kaveh found out a truth about Parisa’s older sister but he did not mention it.’

33

a.

Hamed	estedlali		darmorede	mas'aleh	kard	vali	natavanest
Hamed	reasoning-INDEF		about	(the) matter	did	but	could not
ostadash	ra:		mojab	konad			
his professor	ACCUS		convince				

‘Hamed made a reasoning about the problem but did not manage to convince his professor.’

b.

Hamed	estedlali		darmorede	mas'ale-ye	mali-e	sherkat
Hamed	reasoning-INDEF		about	matter	financial(of)	company
kard	vali	natavanest	ostadash	ra:	mojab	konad
did	But	could not	his professor	ACCUS	convince	

‘Hamed made a reasoning about the company’s financial problem but did not manage to convince his professor.’

c.

Hamed	charei		dar morede	mas'aleh	andishid	va
Hamed	solution-INDEF		about	(the) matter	thought	and
esrar	dasht	a:n	ra:	amali	konad	
insisted	that	ACCUS	execute			

‘Hamed thought of a solution about the problem and insisted to execute it.’

d.

Hamed	charei		dar morede	mas'ale-ye	mali-e	sherkat
Hamed	solution-INDEF		about	matter	financial(of)	company
andishid	va	esrar	dasht	a:n	ra:	amali
thought	and	insisted	that	ACCUS	execute	

‘Hamed thought of a solution about the company’s financial problem and insisted to execute it.’

34

a.

Hossein	eshtebahi		dar morede	hamsarash	kard	va	a:n
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Hossein	mistake-INDEF	about	his wife	did	and	that
eshtebah	ba'ese	jodayie	a:n-ha: shod			

mistake cause (of) separation (of) them was
 'Hossein made a mistake about his wife and this caused of their separation.'

b.

Hossein	eshtebahi		dar morede	hamsar-e	mehraban	va
Hossein	mistake-INDEF		about	his wife	kind	and
fadakarash	kard va	a:n	eshtebah	ba'ese	jodayie	
devoted	did and	that	mistake	cause (of)	separation(of)	

a:n-ha: shod

them was

'Hossein made a mistake about his kind and devoted wife and this caused of their separation.'

c.

Hossein	nokte'i	dar morede	hamsarash	fahmid	va
Hossein	point-INDEF	about	his wife	understood	and
ba'es shod	ehsasash	dar morede	u	taghir konad	
caused	his feeling	about	her	change	

'Hossein found out of a point about his wife which cause his feelings of her to change.'

d.

Hossein	nokte'i	dar morede	hamsar-e	mehraban	va
Hossein	point-INDEF	about	his wife	kind	and
fadakarash	fahmid	va	ba'es shod	ehsasash	dar morede
devoted	understood	and	caused	his feeling	about
					u

taqir konad

change

'Hossein found out of a point about his kind and devoted wife which cause his feelings of her to change.'

35

a.

Nazanin	tasmimi		dar morede	xodash gereft	va	hameye
Nazanin	decision-INDEF		about	herself got	and	all (of)
talashash	ra:	kard	ta	a:n	ra:	ejra konad
her effort	ACCUS	did	so that that	ACCUS		accomplish

'Nazanin made a decision about herself and did her best to accomplish that.'

b.

Nazanin	tasmimi		dar morede	ayande-ye	kari-e	xodash gereft
Nazanin	decision-INDEF		about	future	job	herself got
va	hameye	talashash	ra:	kard	ta	a:n
and	all (of)	her effort	ACCUS	did	so that that	ACCUS

konad

accomplish

'Nazanin decided about future of her job and did her best to accomplish that.'

c.

Nazanin	vaqeiati	dar morede	xodash fahmid	va	fekrash
Nazanin	truth-INDEF	about	herself understood	and	her mind
hesabi	mashghul	shod			
so much	busy	got			

‘Nazanin found out of a truth about herself and her mind got so busy.’

d.

Nazanin	vaqeiati	dar morede	ayande-ye	kari-e	xodash fahmid
Nazanin	truth-INDEF	about	future	job	herself understood
va	fekrash	hesabi	mashghul	shod	
and	her mind	so much	busy	got	

‘Nazanin found out of a truth about future of her job and her mind got so busy.’

36

a.

Mehdi Eterafi		dar	dadgah	kard	va	be	habs-e
Mehdi confession-INDEF		at	(the) court	did	and	to	imprisonment
abad	mahkum	shod					
permanent	condemned	got					

‘Mehdi made a confession in the court and got condemned of imprisonment for ever.’

b.

Mehdi Eterafi		dar	dadgah-e	alani-e	dirooz	kard
Mehdi confession-INDEF		at	court	public	yesterday	did
va	be	habs-e	abad	mahkum	shod	
and	to	imprisonment	permanent	condemned	got	

‘Mehdi made a confession in yesterday’s public court and got condemned of imprisonment for ever.’

c.

Mehdi shahadat-namei		dar	dadgah	nevesht	va	be
Mehdi testimony-INDEF		at	(the) court	wrote	and	to
habs-e	abad	mahkum	shod			
imprisonment	permanent	condemned	got			

‘Mehdi wrote a testimony in the court and got condemned of imprisonment for ever.’

d.

Mehdi shahadat-namei		dar	dadgah-e	alani-e	dirooz
Mehdi testimony-INDEF		at	court	public	yesterday
nevesht	va	be	habs-e	abad	mahkum
wrote	and	to	imprisonment	permanent	condemned
					got

‘Mehdi wrote a testimony in yesterday’s public court and got condemned of imprisonment for ever.’

Appendix C. The fillers used in the experiments

1.
man va Baha:re diruz ba:hambe madrese raftim va sare
I and Bahare yesterday together to school went and in
kelas xa:bema:n- bord
class asleep fell-PST
‘I and Bahare went to school together yesterday and fell asleep in the class.’
2.
man ke xeili gorosneh budam az maqa:ze-i: ke nazdik-e
I who very hungry was from a-shop which close to
xa:ne bud iek sandevich sosis xaridam
home was one sandwich sossage buy-1.S-PST
‘I was very hungry and bought a sossage sandwich from a shop near home.’
3.
dalam mixa:stba: tama:m-e wujud baraie doxtar-e hamsa:ye gerye
my-heart wanted with all being for daughter-of neighbor cry
konam a:xar diruz pedarash ra: az dast da:d
do-1.S because yesterday her-father ACCUS from hand give-PST
‘I wanted to cry sincerely for my neighbor’s daughter because she lost her father yesterday.’
4.
belaxare da:riush tasmim-gereft ma:shinash ra: befrushad
finally Darius decision-took his-car ACCUS sell
va iek docharxe bexarad
and one bike buy
‘Finally Darius decided to sell his car and buy a bike.’
5.
dishab mehma:ni-e dust-e xa:haram xosh gozasht
last-night party-of friend-of my-sister fun passed
amma: ja:ie to xa:li bud.
but place(of) you empty was.
‘Last night at my sister’s friend’s party, we had lots of fun but you were missing you.’
6.
A:ida: ba:iad hameie leba:sha:iash ra: mishost chon leba:se
tamizi
Aida must all her-clothes ACCUS wash because clothes
tamiz baraie ka:rash nada:sht.
clean for her-work didnot-have.
‘Aida had to wash all her clothes as she had no clean clothes for work.’
7.
Ahmad be Omid fote pedarash ra: tasliat goft
Ahmadto Omid death-of his-father Assus condolences said
va be mara:seme xa:ksepa:ri raft.
and to ceremony funeral went.
‘Ahmad solaced to Omid for death of his father and went to his funeral.’

8.
man diruz hameie kolucheha: ra: xordam ba:-inke
I yesterday all cookies ACCUS eat-PST even-though
qablash na:ha:re mofasali ham xorde budam.
before-that lunch-ez full too eat was.1.S.
‘I ate all the cookies yesterday even though I had eaten a full meal for lunch.’
9.
diruz ba: komake hamsa:ie diva:re haia:t ra: rang kardam
yesterday with help neighbour wall-of yard ACCUS paint did.1.S.
chon xeili sa:l bud ke rang naxorde-bud.
because very year was that paint eat-not-PAST
‘Yesterday with the help I got from my neighbor, I painted the yard’s wall as it hadn’t been painted for so many years.’
10.
agar az da’ie Sa:na:z bexaham hatman komakam
if from uncle-ez Sanaz want surely help-me
mikonad chon xeili marde mehraba:ni ast.
do because very man kind is.
‘If I ask Sanaz’s uncle, he will help me for sure as he is a very kind man.’
11.
man dar kudaki xeili sheitanat mikardam va az diva:re ra:st
I in childhood very mischief do and from wall straight
bala miraftam.
up go.1.S.PST
‘In my childhood I used to make lots of mischief.’
12.
cheshm-haie Fariba qermez shode-bud amma be ruie xodash nemi’a:vard.
eyes-of Fariba red became-was but to face herself didnot-bring.
‘Fariba’s eyes had become red but she was trying to make a poker face.’
13.
Parinazdishab be jashne tavalode dustash rafte bud va
Parinazlast-night to party birhtday her-friend went was and
dirvaqt bargasht.
late came-back.
‘Parinaz had gone to her friend’s birthday party last night and came back late.’
14.
az vaqti ke Parvin raft digar in xa:ne range a:ra:mesh be
since time that Parvin went other this house color peace to
xod nadide ast.
itself not-seen is.
‘Since the time Parvin left, there was never calmness in this house.’
15.
vaqti goftam ke mixa:ham bargardam hame shokke
when said-1.S that want-1.S go-back-1.S everybody shocked
shode budand.
became were.

‘When I said that I would not go back, everybody got shocked.’

16.

man az xode moallemam shenidam ke migoft emsa:l
I from himself teacher heard that said this-year
emteha:na:t saxtar az sa:le gozashte bud.
exams more-difficult than year last was.

‘I heard from the teacher himself that the exams will be more difficult than the last year.’

17.

To ba:iad beda:nike in xa:ne moqarara:ti da:rad va ba:iad be
you must know that this house rules have and must to
a:nha ehtera:m bogza:ri
those respect put.

‘You must know that this house has rules and you must respect them.’

18.

doctor be man goft ke ba:iad dar xa:ne estera:hat konam va
doctor to me said that must in house rest do-1.S and
ma:iea:te zia:di benusham
liquids much drink.

‘The doctor told me that I should rest at home and drink lots of liquids.’

19.

man az hava:peima mitarsidam amma vaqti sava:r shodam
I from airplane scared.1.S but when onbroad got
tarsam rixt
my-fear poured.

‘I was afraid of airplanes but when I got abroad my fear vanished.’

20.

xa:neie madarbozorgam xeili qadimist ama haiate bozorgi
house-of my-grandmother very old-is, but yard big
darad ke por az golhaieatlasi ast
has which full of flowersPetuniaais is.

‘My grandmother’s house is too old but it has a big yard full of Petunia flowers.’

21.

pedare keivan ba vojude inke varshekast shod hichvaqt
father-of Keivanwith existence that bankrupted became never
dast az talash barnadasht
hand from attempt pick-up.not.PST

‘Even though Keivan’s father got bankrupted never stopped trying.’

22.

diruz dar madrese be soali ke moalem porsid
yesterday in school to a-question which teacher asked
javab dadam va moalem hesabi tashviqam kard
answer gave and teacher so-much praise did.

‘Yesterday I answered the question that the teacher asked and the teacher praised me a lot.’

23.

hamkelasie man xeili dars mixanda mma hichvaqt nomreie

classmate-of me very lesson read but never mark
 balai nemigereft
 high got.

‘My classmate used to study a lot but never got a high mark.’

24.

Qazale diruz sa’atha: ruie nimkate park neshast va
 Qazale yesterday hours on bench-of park sit-PST and
 fekr kard
 think did.

‘Yesterday Qazale sat on the bench of the park for hours and thought.’

25.

Zohre parsal dar da:neshga:he a:za:d qabul shod ama naraft
 Zohre last-year in university-of free accepted got but didnot-go
 chon nemitavanest shahrie-ash ra: bepardazad
 because couldn’t tuition-fee ACCUS pay.

‘Zohre got accepted in free university last year but did not enroll as she could not pay the tuition fee.’

26.

man dishab dustanam ra: be xa:ne davat kardam
 I last-night my-friends ACCUS to home invite did
 va iek qazaie xoshmaze poxtam
 and one meal delicious cooked.

‘Last night I invited my friend to my home and cooked a delicious meal.’

27.

Afsane hichvahqt az chizi shekaiat nemikard ama diruz
 Afsane never from things complain didnot but yesterday
 hesabi sedaiash dar-a:made-bud
 very her-voice came-out.

‘Afsane used to never complain about anything but yesterday she got really mad.’

28.

Ehsan tasmim gereft ke bejaie daneshgah be sarbazi
 Ehsan decision took that instead-of university to military-service
 beravad va raft
 go and went.

‘Ehsan decided to do the military service instead of going to university and he did so.’

29.

to xub midani ke man az che rafta:ri badam miaiad ama
 you well know that I from what behavior dislike comes and
 bazham a:n ra: tekra:r mikoni
 again that ACCUS repeat do.

‘You know well what kind of behavior I hate but still you repeat it.’

30.

dishab az xa:b paridam va digar xa:bamnabord
 last-night from sleep jump.1.S and no more sleep didnot-take.

‘Last night I got awakened and didn’t manage to sleep anymore.’

31.
man diruz hich lebasi naxaridam agarche hesa:bi
I yesterday nothing clothers didnot-buy even-though a lot
gashte budam
search was.
‘I did not buy any clothes yesterday even though I had searched a lot.’
32.
Davud diruz a:nqadr xaste bud ke natava:nest be sare-ka:r
Davud yesterday that-much tired was that couldnot to work
beravad va dar xa:ne ma:nd
got and in home stayed.
‘Yesterday Davud was so tired that he did not manage to go to work and stayed at home.’
33.
Ela:he ke dasht ba:l dar-miavard be man goft ke daneshgah
Elahe who had wing take-out to me said that university
qabul shode ast
accepted become is.
‘Elahe who was extremely happy told me that she has got accepted for entrance to university.’
34.
dishab az xa:neie doxtar-xa:le-am ke barmingashtam
last-night from house-of my-cousin that came-back
kifam ra: dozdidand
my-purse ACCUS stole.
‘Last night when I was coming back from my cousin’s house someone stole my purse.’
35.
man be resturane hamishegi raftam amma tatil bud
I to resturant usual went but closed was
‘I went to the resturant that I go to usually but it was closed.’
36.
Parvane be-xa:tere man television ra: xa:mush kard
Parvane for me television ACCUS off did
ta bida:r nashavam
so-that awake not-become-1.S
‘Parvane turned off the TV so that I do not wake up.’
37.
Soheil chand-vaqt pish be man goft ke mixa:had ba
Soheil sometime ago to me said that want with
pedarash dar-in-mored harf bezanad.
his-faher about-this talk hit.
‘Soheil told me some time ago that he wants to talk to his father about this matter.’
38.
vaqti Peimanbaraiam ahang zad ashk dar cheshmanam halqe zade
when Peimanfor-me song hit teardrop in my-eyes ring hit
bud
was.

‘When Peiman played a song for me, I was about to cry.’

39.

Mehrdad a:nqadr talash kard ta belaxare be ja:igahi
Mehrdad that-much try did that finally to the-level
ke mixast resid
which wanted reached.

‘Mehrdad tried so much that finally got to the level he wanted.’

40.

duste man ke dar Paris زندegi mikonad diruz
frind-of me who in Paris life does yesterday
be man telefon zad
to me telephone hit

‘The friend of mine who lives in Paris yesterday called me.’

41.

shabi ke Farzane ra: didam ba:ra:ne shadidi
night which Farzane ACCUS saw rain intense
mibarid va chatram ra: faramush karde budam
rained and my-umbrella ACCUS forget did was.1.S.

‘That night which I saw Farzane it was raining heavily and I had forgotten to take my umbrella.’

42.

man dar kudaki footba:l dust dashtam va xub ham
I in childhood football like had and good too
ba:zi mikardam
play do-1.S.PST

‘In my childhood, I liked football and used to play well too.’

43.

diruz ke az madrese bargashtam xeili gorosne budam amma
yesterday which from school came-back very hungry was but
xabari az qaza nabud
news from food was-not

‘Yesterday when I came back from school, I was very hungry but there was no food.’

44.

Mila:d tamame ruz ra: ra:nandegi kard va xeili xaste
Milad all day ACCUS driving did and very tired
shod
became.

‘Milad drove the whole day and got very tired.’

45.

man diruz zud be xa:ne bargashtam amma kelidam
I yesterday soon to home came-back but my-key
ra: ja-gozashte-budam
ACCUS had-left

‘I came back home early yesterday but I had left my key somewhere.’

46.

Bijan ra:dio ra: roshan kard vali barname-ie morede-ala:qe-ash

Bijan radio ACCUS on did but program-of his-interest
 tamam shode bud
 finish became was.

‘Bijan turned on the radio but his favorite program was over.’

47.

Shahab va A:va: diruz az shomal bargashtand va be
 Shahab and Ava yesterday from north came-back and to
 xa:neie xa:hare A:va: raftand
 home-of sister-of Ava went.

‘Yesterday Shahab and Ava came back from the North region and went to Ava’s sister’s place.’

48.

man az miveha:ei ke xeili reside bashad badam mia:mad va
 I from fruits which very ripe be dislike came and
 lab nemizadam
 lib not-hit

‘I used to dislike too ripe fruits and never touched them.’

49.

Farid az man be-xa:tere ettefa:qe diruz mazerat xa:st
 Farid from me because-of happening yesterday excuse asked
 va man ham u ra: baxshidam
 and I too him ACCUS forgave

‘Farid apologized for what happened yesterday and I also forgave him.’

50.

man ke hamishe az ertefa: mitarsidam diruz ba
 I who always from height scared yesterday with
 Dustanam be kuh raftam
 my-friends to mountain went

‘I used to always be afraid of height but yesterday I went to mountain-climbing with my friends.’

51.

Mahmud be qasa:bi raft va bara:ie mehma:nie emruz do kilu
 Mahmud to butcherwent and for party-of today two kilos
 juje xarid
 chicken bought

‘Mahmud went to butcher and bought two kilos of chicken for today’s party.’

52.

Shima ke hesa:bi gij shode bud az man porsid ke
 Shima who very confused become was from me asked that
 sa’at chand ast
 hour what-time is

‘Shima who had totally got confused asked me what the time is.’

53.

man bad-az sa:lha: Mona ra: dar taksi didam va u
 I after years Mona ACCUS in taxi saw and her
 ra: shena:xtam

ACCUS know

'I saw Mona after so many years in a taxi and remembered her.'

54.

Sa'id nasihati be man kard ke hargez fara:mush nemikonam
Sa'id advice to me did which never forget not-do
'Sa'id gave me an advice which I will never forget.'

55.

A:za:de dishab a:nqadr qaza: xordeh bud ke del-dard
Azade last-night that-much food eat was that stomachache
gereft
got
'Azade had eaten so much food that she got stomachache.'

56.

Mohammad be Zahra: angoshtari hedie da:d agarche asl
nabud
Mohammad to Zahra ring present gave even-though genuine
weren't
'Mohammad gave a present to Zahra, even though it was not genuine.'

57.

man az shuxie diruze Sahar xosham naiamad va birun raftam
I from joke yesterday Sahar like not-come and out went
'I didn't like the joke Sahar made yesterday and went out.'

58.

man diruz ba sharikam qara:r gozashtam ke dar-morede poroje
I yesterday with my-copartner appointment put that about project
sohbat konam
talk do-i
'I made an appointment with my copartner to talk about the project.'

59.

Ha:nie belaxare moevajeh shod ke dar-morede Navid
Hanie finally notice become that about Navid
eshtebah mikarde ast
mistake did is
'Hanie finally figured out that she had made a mistake about Navid.'

60.

Ebra:him bad-az inke be Esfehan raft kare jadidi ra:
Ebrahim after that to Isfahan went work new ACCUS
shoru kard
start did
'After Ebrahim went to Isfahan, he started a new job.'

61.

baradaram ke az man bozorgtar bud hamishe mara:
my-brother who from me older was always me-ACCUS
hema:iat mikard
support did
'My brother who was older than me used to always support me.'

62.
 Sia:mak hafteie pish reza:iat dad ke Ruzbeh az
 Siamak week ago consent gave that Ruzbeh from
 zenda:n a:za:d shavad va dieh napardazad
 prison free become and ransomnot-pay
 ‘Last week Siamak consented so that Ruzbeh get released from prison without paying the ransom.’
63.
 Ja:leh bara:ie man iek kola:hegarm baft ke xeili xoshrang bud
 Jaleh for me one hat warm knitted which very nice-color was
 ‘Jaleh knitted a warm hat for me which was of a pretty color.’
64.
 Fahimeh do hafte pish mariz shod va moraxasie
 Fahimeh two week ago sick become and leave
 este’la:ji gereft
 sick got
 ‘Fahime got sick two weeks ago and got a sick leave.’
65.
 Sohra:b ba man tamas gereft va hamechiz ra:
 Sohrab to me contacttook and everything ACCUS
 tozih dad
 explanation gave
 ‘Sohrab contacted me and explained everything.’
66.
 man diruz iek joft kafshe no baraie xodam xaridam ke
 I yesterday on pair shoe new for myself bought which
 xeili gera:n bud
 very expensive was
 ‘I bought a new pair of shoes for myself which were very expensive.’
67.
 Sha:ia:n pa:rsa:l dar mosabeqeie shatranj barande
 Shaian last-year in competition chess winner
 shod ba-inke ziad tamrin nakarde bud
 became even-though much practice didn’t was
 ‘Shaian won a chess competition last year even though he had not practised much.’
68.
 Ba:bak diruz be man komak kard ba-vojude-inke sarash
 Babak yesterday to me help did although his-head
 xeili sholuq bud
 very busy was
 ‘Babak helped me yesterday even though he was very busy.’
69.
 Shiva: diruz supe xoshmazei dorost karde bud ke mesle
 Shiva yesterday soup delicious cook did was that like
 hamishe xeili chasbid

always a lot stuck

‘Shiva made a delicious soup yesterday which I/we enjoyed it as always.’

70.

pedram vaqti xaste shod be iek a:hange jadid gush
Pedram when tired became to one music-track new listen
dad
did

‘When my father got tired he listened to new track.’

71.

man az atri ke La:le baraiam hedi gerefte bud
I from perfume which Lale for-me present taken was
xosham naia:mad amma be ruie xodam naia:vardam
like not-come but to face myself didnot bring

‘I did not like the perfume that Laleh had bought for me as a present but I tried to make a poker face.’

72.

modire sherkat diruz az sheddate na:ra:hati
manager-of company yesterday from intensity sadness
estefa: dad va az ota:q birun raft
resignation did and from room out went

‘The company’s manager was so sad that he resigned and left the room.’

73.

man baraie tavalode xa:harza:de-am iek mashine kontroli
I for birthday-of my-cousin one toy-car remote-control
xaridam ke xeili pishrafte bud
bought which very advanced was

‘For my cousin’s birthday, I bought a remote-control toy car which was very advanced.’

74.

Ra:minnemitavanest jeloie xodash ra: begirad va zad
Ramin couldn’t front herself ACCUS stop and hit
zire xande
under laugh

‘Ramin couldn’t help laughing and burst out laughing.’

75.

Marja:n ke az raftare Behruz hesabi sha:ki bud ba
Marjan who from behavior-of Behruz very-much angry was with
u chand ruzi qahr kard
him few days huff did

‘Marjan who was so angry of Behruz’s behavior huffed with him for a few days.’

76.

pedarbozorgam a:n deraxt ra: xeili dust dasht va
my-grand-father that tree ACCUS much like had and
nemigozasht kasi az a:n bala: beravad
didn’t-let someone from that top go

‘My grandfather liked that tree so much that wouldn’t let anyone go on top of it.’

77.

man diruz az sobh ta shab dars xa:ndam ke
 I yesterday since morning to night lesson read-1.S. that
 bara:ie emteha:n a:ma:de ba:sham
 for exam ready be-1.S

‘Yesterday I studies since morning till night to get ready for the exam.’

78.

A:rezu hafteie pish iek bache gorbe peida kard va a:n ra:
 Arezu week ago one kid cat find did and that ACCUS
 be xa:ne a:vard
 to home brought

‘Arezu found a kitten last week and brought it home.’

79.

Mojde az safar ke bargasht bela:fa:sele ka:rash ra:
 Mojde from trip that came-back immediately her-work ACCUS
 shoru kard
 begin did

‘As soon as Mojde came back from the trip started her work.’

80.

ra’is be man moraxasi dad ke betavanam be ka:rhaie
 boss to me vacation gave that can to works
 aqab-ma:nde-am beresam
 lagged-my arrive

‘The boss let me go off so that I can work on my lagged works.’

81.

doxtaram ke panj sa:lash ast diruz baraie tavalodam iek
 my-daughter who five years is yesterday for my-birthday one
 naqashi keshid
 painting drew.

‘My daughter who is five years old gave me a painting for my birthday.’

82.

Human nemixast pishnehade hamka:rash ra: qabul konad
 Human didn’t-want offer-of his-colleague ACCUS accept do
 amma belaxare majbur shod
 but finally forced became.

‘Human didn’t want to accept his colleague’s offer but he got obliged to.’

83.

Sogol az inke natavanestam be jashne arusie u beravam
 Sogol from that couldnot-1.S to party wedding-of her go
 bothered shod
 sad became

‘Since I couldn’t go to her wedding, Sogol got bothered.’

84.

Ashka:n pa:rsa:l shoru kard ke iek sa:ze jadid iad-
 Ashkan last-year start did that one instrument new learn
 begirad
 get

‘Last year Ashkan began to learn a new musical instrument.’

85.

Parastu	ke	xeili	asaba:ni	bud	dar	ra:	poshte
Parastu	who	very	angry	was	door	ACCUS	behind
sarash	be	ham	kubid				
her-head	to	each-other	hit				

‘Parastu was very angry and closed the door by force while leaving.’

86.

Fereshte	natava:nest	jeloie	ehsa:sa:tash	ra:	begirad	va
Fereshte	couldnot	front	her-emotions	ACCUS	catch	and
boqzash	terekid					
her-hatred	broke					

‘Fereshte didn’t manage to control her emotions and burst out crying.’

87.

Sorush pa:rsa:l	ma:shinash	ra:	avaz	kard	va	iek
Sorush last-year	his-car	ACCUS	change	did	and	one
ma:shine	model-jadid	xarid				
car	brand-new	bought				

‘Sorush changed his car last year and bought a brand-new car.’

88.

Pa:rsa: shabe	qabl	az	arusi	tasa:dof	kard	va	pa:iash shekast
Parsa night	ago	from	wedding	accident	did	and	his-leg broke

‘The night before wedding, Parsa had an accident and got his leg broken.’

89.

Sia:vash	nemixa:st	ke	man	az	mozu	sar	dar	bia:varam
Siavash	didn’t-want	that	I	from	topic	head	out	bring
va	na:ra:hat	shavam						
and	sad	become						

‘Siavash didn’t want me to figure out the topic and get sad.’

90.

Dishab	ke	xa:bam	nemibord	be	Ia:saman	telefon
last-night	that	sleep	didnot-take	to	Iasaman	telephone
zadam va	ba:ham	kolli	harf	zadim		
hit	and	together	much	talk	hit	

‘Last night I could not sleep and called Iasaman and we talked a lot.’

91.

man	az	ruzi	ke	fareqottahsil	shodam	digar	hamkelasihaiam
I	since	day	which	graduation	became	other	classmates
ra:	nadidam						
ACCUS	didnot-see						

‘Since I got graduated, I haven’t seen my classmates.’

92.

Nasrin diruz	dir	az	sare	ka:r	bargasht	va	xeili	xaste
Nasrin yesterday	late	from	head	work	came-back	and	very	tired
bud								

was

‘Yesterday Nasrin came back late from work and was very tired.’

93.

Mahshid ke xeili shokke shode bud nemitavanest harf
Mahshid who very shocked become was couldnot talk
bezanad
hit

‘Mahshid who was so shocked couldn’t talk.’

94.

Xa:leie Narges vaqti diruz sarzade be xa:neie ma: a:mad
Aunt Narges when yesterday unexpectedly to house-of us came
xeili zoq kardim
very excited got

‘We got so excited when Narges’ aunt visited us unexpectedly.’

95.

man be Henga:me puli ke ehtiaj da:sht ra: qarz da:dam
I to Hengame money which need had ACCUS lend gave
amma u hanuz be man pas-nada:de ast
but she still to me not-give-back is

‘I lent Hengame the money she needed but she has not given that back to me yet.’

96.

xa:haram dishab iek keike shokola:ti bara:iam dorost kard
my-sister last-night one cake chocolate for-me bake did
ke xeili mazze da:d
which very taste gave

‘Last night my sister baked a chocolate cake for me and I/we enjoyed it a lot.’

97.

Ma:zia:r hafteie pish be man goft ke mixa:had be Shira:z
Maziar week ago to me said that want to Shiraz
beravad
go

‘Last week Maziar told me that he wants to go to Shiraz.’

98.

Roshanak ke doxtare ziba:ei ast aslan etema:d be
Roshanak who girl beautiful is at-all confidence to
nafse xubi nadarad
self good doesnot-have

‘Roshanak who is a beautiful girl does not have a high self-confidence at all.’

99.

Sa:ma:n diruz be bima:resta:n raft ta cheshmas
Saman yesterday to hospital went to his-eyes
ra: amal konad
ACCUS surgery do

‘Yesterday Saman went to hospital to have his eyes under surgery.’

100.

A:rash	dishab	az	man	ma:shinam	ra:	qarz	gereft
Arash	last-night	from	me	my-car	ACCUS	borrow	took
ta	be	mehma:ni	beravad				
so-that	to	party	go				

‘Last night Arash borrowed my car to go to a party.’

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Summary

In the literature of sentence processing, there are two seemingly contradicting accounts for resolving long-distance dependencies: (1) memory-based account according to which delaying the appearance of a verb in a noun-verb dependency tends to increase the processing difficulty at the position of verb leading to the so-called locality effect (Gibson, 2000), and (2) expectation-based account, based on which the verb becomes even more predictable and easier to process due to this delay leading to the so-called surprisal effect as the reader is highly expecting the verb (Levy, 2008). Levy and colleagues (2013) argue that the verb-medial languages tend to exhibit the general patterns predicted by memory-based theories, while verb-final languages tend to exhibit the general pattern predicated by expectation-based theories.

We aimed to investigate these two accounts on Complex Predicates in Persian as a verb-final language in which multiple-word verbs (i.e., complex predicates) are more widely-used as compared the one-word verbs. To this purpose, four psycholinguistic experiments (two masked self-paced reading studies and two eye-tracking studies) with four pre-tests (two sentence-completion studies, one acceptability rating study, and one corpus study) with a total of 279 participants were conducted in different homogenous groups of native Persian speakers with no history of cognitive disorders and normal or corrected-to-normal eye-sight. In our experimental design (2x2), we opposed complex predicate conditions to simple predicate conditions and manipulated the stimuli by two factors of distance (i.e., short conditions versus long conditions) and predictability (i.e., strong predictability versus weak predictability). The intervener in the first self-paced reading study and the first eye-tracking study was a short prepositional phrase in the short conditions and a prepositional phrase plus a relative clause in the long conditions. In the second

self-paced reading and the second eye-tracking studies, the intervener consisted of the same short prepositional phrase in the short conditions whereas it was a long uninterrupted prepositional phrase in the long conditions. We decided to keep the same type of intervener in the long conditions of the second design in order to find out if the type of intervener affects the processing difficulty.

From the perspective of memory-based accounts, we expected a main effect of distance, such that processing the long conditions would be more difficult than processing the short conditions. The expectation-based accounts predict either no effect of distance or a facilitation at the verb as a function of distance. Also, a main effect of predictability is expected, such that there are faster reading times in strong versus weak conditions, regardless of distance. In other words, a facilitation effect is predicted in the long versus short conditions, as the more amount of information leads to less surprisal. We also expected that the second design in which less syntactic complexity (only one type of intervener) was included would be easier to process as compared to the first design where two chunks of different linguistic types were used as the intervener.

Before these experiments, we conducted some pretests in order to make sure that our experimental stimuli are appropriate for the purpose of the main experiments. To this aim, two sentence-completion studies were done on two different groups of participants (32 each). We were interested in understanding whether the participants can predict the light verbs or the heavy verbs we planned to use in the self-paced reading and eye-tracking experiments if they were given the sentence up to the pre-critical region. The aim was to ensure that the light verbs of the complex predicates were highly predictable (for strong predictability conditions) and the heavy verbs of the simple predicates had weak predictability, which was confirmed by these two studies.

Consequently, we managed to confirm that it was acceptable for the native speakers of Persian (50 participants) to separate the complex predicates used in the experimental sentences. Lastly, we used Persian corpora to show that the conditional probability of appearing the upcoming verb increases as the distance between the nominal and the light verb becomes larger. Also, a comparison of Persian and Hindi dependency treebanks showed that the adjacency of complex predicates is more preferred in Persian than in Hindi even though it can be considered acceptable as confirmed by our acceptability rating study. These studies helped us ensure that we had a well-designed setup, enabling us to proceed to the main experiments.

In the first self-paced reading study with 42 participants, we found a main effect of predictability such that the verbs in the strong predictability conditions were read faster than the weak predictability conditions, and a main effect of distance, such that the verbs in the short conditions were read faster than the long conditions. Within the weak predictability conditions, the reading time at the position of the verb in the short condition was faster than the reading times in long condition. A weak interaction suggests that the locality effect may be somewhat stronger in the weak predictability condition. A marginal effect of interaction between predictability and distance seems to provide only weak support, if any, for the idea that strong predictability can at least attenuate locality effects (Husain et al., 2014).

In the second self-paced reading study with 43 other participants, we replicated the locality effects found in the first experiment, but we no longer saw a weakening of the locality effect that was seen in experiment 1 (a marginal interaction between the distance and predictability in experiment 1 such that the locality effects might get weakened as a result of strong predictability). The strength of locality effects was equal in the strong and weak predictability conditions. In the second self-paced reading, we also see an effect of predictability, with the strong predictable verb being

read faster. So, regarding the distance manipulation, the prediction of the working-memory account was validated, and the prediction of the expectation-based account was not supported. The main effect of predictability did not furnish evidence consistent with the expectation-based account.

In both self-paced reading experiments, there was a main effect of distance which was in favor of the memory-based accounts, that is, the locality effect. In other words, lengthening the intervening materials led to more difficulty in processing. This effect was even stronger in the second experiment where the intervener was the same type, contrary to our expectation that keeping the same nature of the intervener can facilitate processing. The response accuracy in both of these experiments was slightly higher in the short conditions versus long conditions even though there was no main effect of predictability to confirm that this difference was significant.

Eye-tracking method represents a more natural pattern of reading and provides more details on the proportion of eye-gaze (e.g. the first-pass reading time and the regression-path duration in which we were interested, as compared to the reading time data in the self-paced reading experiments). In the first eye-tracking study with 40 participants, we replicated the locality effects found in the reading time of self-paced reading studies. These locality effect appeared in weak-predictability conditions, which is similar to the result of the first self-paced reading as discussed in chapter 3. A main effect of predictability was found in first-pass reading time and regression path duration, replicating the effect in self-paced reading 1. Since we failed to find an interaction between predictability and distance, we cannot conclude, as Husain et al. (2014) did, that expectation effects can cancel out locality effects.

The second eye-tracking experiment with 40 other participants replicated the results of the second self-paced reading experiment: there was a main effect of distance and a main effect of predictability, with no evidence for an interaction. The effects in

first-pass reading time and regression-path duration showed essentially the same patterns as in the first eye-tracking study. However, the locality effects were even stronger, in the same way that the second self-paced reading study showed stronger locality effects. Also, these effects are equally strong in both the strong and weak predictability conditions, which confirms our finding in the second self-paced reading study.

Similar to the self-paced reading experiments, the main effect of distance found in the first pass reading time and regression path duration as the two key eye-tracking measures was in favor of the memory-based accounts, and there was no compelling evidence that the locality effects get weakened by strong predictability. It is worth mentioning that the locality effects are higher in strong predictability conditions compared to weak predictability conditions. Therefore, we failed to find evidence in favor of expectation-based account to conclude that increasing the distance between the noun and the verb leads to facilitation in processing due to increasing conditional probabilities of the upcoming verb. The average response accuracy to the comprehension-check questions in both eye-tracking experiments was above 90 % which showed that the participants paid full attention to all parts of the sentences. However, there was no significant difference in the response accuracy across the conditions.

In conclusion, as regards the distance manipulation, the evidence from Persian is in favor of working memory accounts and a key prediction of the expectation-based account was not upheld. Although we found a main effect of predictability in all four experiments, we cannot be certain that this effect is not due to other factors such as frequency as the words in the strong versus weak predictability conditions are not precisely the same. A possible further research that can add more insights to the analysis of the experiments is a new design where we directly compare the intervener

types in a within-subject experiment, that is, the same participants read all the conditions in a 3 x 2 factorial design where the intervener in the first condition is a short prepositional phrase, the combination of a prepositional phrase and a relative clause in the second condition, and a long uninterrupted prepositional phrase in the third condition for both simple predicate and complex predicate conditions. This can be a definitive test to compare the differences directly.

Also, there is not much evidence from Persian that strong-predictability conditions cancel locality effects, as Husain and colleagues (2014) suggest. Interestingly, there is no evidence in these experiments for the prediction of the expectation-based account regarding the distance manipulation which argues that increasing argument-verb distance facilitates processing due to increasing conditional probabilities of the upcoming verb. Another interesting observation was that the second self-paced reading and eye-tracking studies, in which the type of intervener in short and long conditions was kept the same, showed even stronger locality effects as compared to the first design -a result contrary to our expectation. So, an uninterrupted phrase of the same type seems to require more processing in the memory rather than a phrase consisting of two types of syntactic constructions.

The suggestion in (Levy et al., 2013) that “the verb-medial languages tend to exhibit the general patterns predicted by memory-based theories, whereas verb-final languages tend to exhibit the general patterns predicted by expectation-based theories seems to be difficult to maintain (also see Husain et al. (2015), for locality effects in Hindi). An implication of our findings from Persian is that locality and expectation effects observed across studies seem to be highly conditional on the language and syntactic construction being considered, so broad cross-linguistic generalizations may be difficult to make. To our best of knowledge, this is the first psycholinguistic experiment in Persian targeting the effects of memory and

expectation on long-distance dependency resolution in sentence processing literature.

Nederlandse samenvatting

In de literatuur over zinsverwerking bestaan twee schijnbaar tegenstrijdige theorieën over ver uit elkaar staande afhankelijke woorden: 1) een geheugen-gebaseerde theorie waaruit volgt dat het uitstellen van het verschijnen van een werkwoord in een combinatie van een van elkaar afhankelijk zelfstandig naamwoord en werkwoord de verwerking op de plek van het werkwoord moeilijker maakt, wat leidt tot het zogenaamde locatiteitseffect (Gibson, 2000), en (2) een verwachtings-gebaseerde theorie, op basis waarvan het werkwoord zelfs beter voorspelbaar en makkelijker te verwerken wordt door dit uitstellen, wat leidt tot het zogenaamde verrassingseffect, daar de lezer het werkwoord verwacht (Levy, 2008). Levy en collega's (2013) stellen dat werkwoord-mediale talen vaak de algemene patronen vertonen zoals voorspeld door geheugen-gebaseerde theorieën, terwijl werkwoord-finale talen vaak het algemene patroon volgen dat wordt voorspeld door verwachtings-gebaseerde theorieën.

Wij hebben geprobeerd deze twee theorieën te onderzoeken ten aanzien van complexe predicaten in het Perzisch (als werkwoord-finale taal), daar deze vaker worden gebruikt dan werkwoorden die uit één woord bestaan. Voor dit doel hebben we een set van 4 psycholinguïstische experimenten uitgevoerd (2 gemaskeerde leesstudies op eigen tempo, en 2 oogbewegingenstudies) met 4 pre-testen (2 zinsvoltooiingsstudies, 1 studie met aanvaardbaarheidsbeoordeling, en 1 corpus-studie). Deze studies, met in totaal 279 deelnemers, zijn uitgevoerd in verschillende homogene groepen deelnemers met Perzisch als moedertaal, zonder achtergrond van cognitieve stoornissen, en met normaal, of gecorrigeerd normaal, gezichtsvermogen. In onze experimentele opzet (2x2) zetten wij complexe predicate omstandigheden tegenover simpele predicate omstandigheden, en manipuleerden we de stimuli door

middel van twee afstandsfactoren (d.w.z. kort uit elkaar versus lang uit elkaar) en voorspelbaarheid (d.w.z. makkelijk voorspelbaar versus moeilijk voorspelbaar). De interventie in de eerste leesstudie op eigen tempo, en de eerste oogbewegingenstudie, was een korte zin met voorzetsel onder de korte omstandigheden, en een voorzetselszin in combinatie met een betrekkelijke bijzin onder de lange omstandigheden. De tweede leesstudie op eigen tempo, en de tweede oogbewegingenstudie, bestonden uit dezelfde korte voorzetselszin onder de korte omstandigheden, en een lange, ononderbroken voorzetselszin onder de lange omstandigheden. We besloten dezelfde soort interventie te gebruiken onder de lange omstandigheden van de tweede studie-opzet, om na te gaan of het type interventie invloed heeft op de moeilijkheidsgraad van de zinsverwerking.

Op basis van geheugengebaseerde theorieën verwachtten we dat afstand het grootste effect zou hebben, en dat de verwerking onder lange omstandigheden moeilijker zou zijn dan de verwerking onder korte omstandigheden. De verwachtings-gebaseerde theorieën voorspellen ofwel dat afstand geen effect heeft, ofwel een facilitatie bij het werkwoord als functie van afstand. Daarnaast wordt een belangrijk effect verwacht van voorspelbaarheid, zodat er, ongeacht afstand, sneller zou moeten worden gelezen onder sterke omstandigheden dan onder zwakke omstandigheden. Met andere woorden: er wordt een facilitatie-effect verwacht onder de lange versus korte omstandigheden, daar meer informatie leidt tot een mindere mate van verrassing. We verwachtten ook dat de tweede opzet, met een lagere syntactische complexiteit (slechts één type interventie) makkelijker te verwerken zou zijn dan het eerste ontwerp, waarin twee stukjes van verschillende linguïstische types als interventie werden gebruikt.

Voorafgaand aan deze experimenten voerden we een aantal pre-testen uit, om er zeker van te zijn dat onze experimentele stimuli geschikt waren voor de

hoofdexperimenten. Hiertoe werden twee zinsvoltooiingsstudies gedaan met twee verschillende groepen deelnemers (beiden met 32 deelnemers). We waren geïnteresseerd in de vraag of de deelnemers de makkelijke of moeilijke werkwoorden die we wilden gebruiken in leesstudies op eigen tempo en de oogbewegingenstudies, konden herkennen, als ze de zinsdelen voorafgaand aan het kritische gebied te zien zouden krijgen. Het doel was om ervoor te zorgen dat de makkelijke werkwoorden van de complexe predicaten zeer voorspelbaar waren (voor zeer voorspelbare omstandigheden), en de moeilijke werkwoorden van de simpele predicaten moeilijk voorspelbaar waren. Dit werd bevestigd door deze twee studies.

Daarmee konden we bevestigen dat het voor de deelnemers met Perzisch als moedertaal (50) acceptabel was om de complexe predicaten die werden gebruikt in de experimentele zinnen, te splitsen. Tot slot gebruikten we Perzische corpora om aan te tonen dat de voorwaardelijke kans van het verschijnen van het eerstvolgende werkwoord toenam, naarmate de afstand tussen het nominale en het makkelijke werkwoord toenam. Ook uit een vergelijking van treebanks in het Perzisch en Hindi bleek dat de nabijheid van complexe predicaten vaker wordt gebruikt in het Perzisch dan in het Hindi, hoewel uit onze aanvaardbaarheidsbeoordelingsstudie blijkt dat dit als aanvaardbaar kan worden beschouwd. Deze studies hielpen ons een goed ontworpen opzet te creëren, waarmee we konden overgaan tot de belangrijkste experimenten.

Uit de eerste leesstudie op eigen tempo, met 42 deelnemers, bleek voorspelbaarheid een belangrijk effect te hebben, en werden werkwoorden onder omstandigheden van goede voorspelbaarheid sneller gelezen dan onder omstandigheden met slechte voorspelbaarheid. Ook bleek afstand een belangrijk effect te hebben, waarbij werkwoorden onder de omstandigheden met korte afstanden sneller werden gelezen,

dan bij lange afstanden. Een genest contrast liet zien dat dit afstandseffect werd veroorzaakt door de omstandigheden van zwakke voorspelbaarheid, d.w.z. dat de leessnelheid rondom de positie van het werkwoord bij korte afstanden en onder omstandigheden van zwakke voorspelbaarheid, korter was dan de leessnelheid bij lange afstanden. Een zwakke interactie suggereert dat het localiteitseffect iets sterker zou kunnen zijn onder omstandigheden van zwakke voorspelbaarheid. Een marginaal interactie-effect tussen voorspelbaarheid en afstand lijkt het idee dat goede voorspelbaarheid localiteitseffecten kan verminderen slechts een klein beetje te ondersteunen, als hier in het geheel al sprake van is (Husain et al., 2014).

In de tweede leesstudie op eigen tempo, met 43 andere deelnemers, repliceerden we de localiteitseffecten uit het eerste experiment, maar vonden we niet langer de verzwakking van het localiteitseffect die bleek uit experiment 1 (een marginale interactie tussen de afstand en voorspelbaarheid in experiment 1, waardoor het localiteitseffect zwakker zou kunnen worden ten gevolge van betere voorspelbaarheid). De sterkte van localiteitseffecten was gelijk onder de omstandigheden met goede en slechtere voorspelbaarheid. Uit de tweede leesstudie op eigen tempo bleek voorspelbaarheid ook een effect te hebben, waarbij het makkelijker te voorspellen werkwoord sneller werd gelezen. Met betrekking tot de manipulatie van afstanden werd de voorspelling van de werkgeheugentheorie gevalideerd, en werd de voorspelling van de verwachtings-gebaseerde theorie niet ondersteund. Het belangrijkste effect van voorspelbaarheid gaf wel bewijs in overeenstemming met de verwachtings-gebaseerde theorie.

Uit beide leesstudies op eigen tempo bleek dat afstand een belangrijk effect had. Dit ondersteunt de geheugengebaseerde theorieën, d.w.z., localiteit. Met andere woorden: het vergroten van tussenliggende afstanden maakt het verwerken moeilijker. Dit effect was nog sterker in het tweede experiment, met dezelfde soort

interventie, in tegenstelling tot onze verwachting dat het vasthouden aan hetzelfde type interventie het verwerken kan vergemakkelijken. De nauwkeurigheid van de antwoorden in deze beide experimenten was iets hoger bij korte afstanden dan bij lange afstanden, hoewel er geen belangrijk effect van voorspelbaarheid werd gevonden dat zou kunnen bevestigen dat dit verschil significant was.

Het volgen van oogbewegingen sluit aan bij een meer natuurlijk leespatroon, en verschaft meer informatie over de verhouding van oog-staren (bijv. de leessnelheden van de eerste passage, en de duur van het regressiepad waar we in geïnteresseerd waren, vergeleken met de gegevens over leessnelheden uit de leesexperimenten op eigen tempo). In de eerste oogbewegingenstudie met 40 deelnemers, repliceerden we de localiteitseffecten die bleken uit de leessnelheden tijdens de leesstudies op eigen tempo. Deze localiteitseffecten waren zichtbaar onder omstandigheden van mindere voorspelbaarheid, en zijn daarmee vergelijkbaar met het resultaat uit de eerste leesstudie op eigen tempo uit hoofdstuk 3. Een van de belangrijkste effecten van voorspelbaarheid bleek uit de leessnelheden van de eerste passage, en de duur van het regressiepad, waarmee het effect uit de eerste leesstudie op eigen tempo werd gerepliceerd. Omdat we geen interactie konden vaststellen tussen voorspelbaarheid en afstand, kunnen we in tegenstelling tot Husain et al. (2014) niet concluderen dat verwachtingseffecten localiteitseffecten kunnen opheffen.

Het tweede oogbewegingenexperiment met 40 andere deelnemers repliceerde de resultaten van het tweede leesexperiment op eigen tempo: afstand en voorspelbaarheid bleken beiden effect te hebben, maar er werd geen bewijs gevonden voor een interactie. De leessnelheden van de eerste passage en de duur van het regressiepad vertoonden vrijwel dezelfde patronen als de eerste oogbewegingenstudie. De localiteitseffecten waren echter sterker, vergelijkbaar met de sterkere localiteitseffecten die bleken uit de tweede leesstudie op eigen tempo.

Bovendien waren deze effecten even sterk onder omstandigheden van goede en slechte voorspelbaarheid. Dit bevestigt onze bevindingen uit de tweede leesstudie op eigen tempo.

Net als bij de leesstudies op eigen tempo ondersteunden de belangrijkste effecten die bleken uit de leessnelheid van de eerste passage en de duur van de regressietijd als twee belangrijkste oogbewegingsindicatoren, geheugen-gebaseerde theorieën, en was er geen overtuigend bewijs voor de stelling dat localiteitseffecten zwakker worden door grote voorspelbaarheid. Het is het vermelden waard dat de localiteitseffecten sterker zijn onder omstandigheden met goede voorspelbaarheid, dan onder omstandigheden met slechte voorspelbaarheid. We vonden dan ook geen bewijs ter ondersteuning van verwachtings-gebaseerde theorieën en kunnen niet concluderen dat het vergroten van de afstand tussen het zelfstandig naamwoord en het werkwoord het verwerken faciliteert ten gevolge van het vergroten van de conditionele waarschijnlijkheid van het komende werkwoord. De gemiddelde antwoordnauwkeurigheid op de controlevragen in beide oogbewegingsexperimenten lag boven de 90%, wat laat zien dat de deelnemers aandacht besteedden aan alle delen van de zinnen. Er zat echter geen significant verschil in de antwoordnauwkeurigheid onder de verschillende omstandigheden.

Wat betreft de manipulatie van afstanden ondersteunt het bewijs voor het Perzisch tot slot de werkgeheugen-gebaseerde theorieën, en bleek een belangrijke voorspelling van de verwachtings-gebaseerde theorieën niet te worden ondersteund. Hoewel voorspelbaarheid in alle vier de experimenten een significant effect bleek te hebben, kunnen we niet met zekerheid vaststellen dat dit effect niet wordt veroorzaakt door andere factoren zoals frequentie, daar de woorden niet precies hetzelfde waren onder de omstandigheden met goede en slechte voorspelbaarheid. Als mogelijk aanvullend onderzoek om meer inzichten te krijgen in de analyse van

de experimenten, zou een nieuw ontwerp kunnen worden bedacht waarin we interventietypes direct vergelijken in een experiment met dezelfde deelnemers. D.w.z. dat dezelfde deelnemers deelnemen aan leesexperimenten onder alle omstandigheden, in een 3x2 factorontwerp, waar de interventie in het eerste deel een korte voorzetselzin is, in het tweede deel een combinatie van een voorzetselzin en een betrekkelijke bijzin, en in het derde deel een lange, ononderbroken voorzetselzin onder omstandigheden van zowel simpele predicaten als complexe predicaten. Met een dergelijke test kunnen de verschillen direct worden vergeleken.

Daarnaast is er voor het Perzisch niet veel bewijs dat goede voorspelbaarheid localiteitseffecten opheft, zoals Husain en collega's (2014) suggereren. Het is interessant dat er in deze experimenten geen bewijs wordt gevonden voor de voorspelling van de verwachtings-gebaseerde theorieën, met betrekking tot de manipulatie van afstanden, namelijk dat het vergroten van de afstanden tussen argumenten en werkwoord het verwerken faciliteert, omdat dit de conditionele waarschijnlijkheid van het komende werkwoord vergroot. Een andere interessante observatie is dat uit de tweede leesstudie op eigen tempo en de tweede oogbewegingenstudie, waarbij het type interventie onder korte en lange omstandigheden gelijk werd gehouden, zelfs sterkere localiteitseffecten bleken dan bij de eerste ontwerpen. Dit ging in tegen onze verwachtingen. Een ononderbroken zin van hetzelfde type lijkt dus meer verwerkingscapaciteit in het geheugen te vereisen dan een zin bestaande uit twee typen syntactische constructies.

De suggestie in Levy et al. (2013) dat “werkwoord-mediale talen vaak de algemene patronen vertonen die worden voorspeld door geheugen-gebaseerde theorieën, terwijl werkwoord-finale talen vaak de algemene patronen vertonen die worden voorspeld door verwachtings-gebaseerde theorieën, lijkt daarmee moeilijk houdbaar (zie ook Husain et al. (2015) voor localiteitseffecten in het Hindi). Een implicatie

van onze bevindingen voor het Perzisch is dat de localiteits- en verwachtingseffecten die blijken uit verschillende studies, sterk afhankelijk zijn van de taal en de syntactische constructie in kwestie. Dit kan het trekken van algemene conclusies voor meerdere talen moeilijk maken. Voor zover wij weten is dit het eerste psycholinguïstische experiment in de literatuur over zinsverwerking dat zich richt op de effecten van geheugen en verwachting op de verwerking van afhankelijkheden over langere afstanden.

About the author

Molood Sadat (Farnoosh) Safavi was born on September 19th, 1986 in Tehran, Iran. Her enthusiasm about literature, poetry, and art since early teen ages flourished her interest to know more about the language phenomenon and led her to pursue linguistic studies as her future career. She touched different aspects of language either as a job or as her field of study. To start with, she studied the Bachelor of arts in English Translation at Allameh Tabataba'i University in Tehran as one of the leading Iranian universities in Humanities. Beside contributing to some book translations, she started teaching English as a foreign language to adults, using different methodologies- an absolutely valuable experience which lasted for 8 years.

Translation and teaching together indeed opened up a new horizon for her. Consequently, at a turning point, she realized that she was truly amazed at how language is processed in the brain. Therefore, she continued to the Master's program of Linguistics at the same university and chose 'Neurolinguistics' as the minor of her Master's thesis. Furthermore, she familiarized herself with the state of the art techniques and programs in Neuroscience by regularly attending the workshops in 'Institute for Cognitive Science Studies' in Iran. Thanks to the helpful training she received theoretically at university and practically at this institute, she got more and more confident about the route she had taken. After attending a series of workshops on TMS, ERP, and experiment design through programs like MATLAB, she conducted an ERP experiment to compare how differently the idioms and non-idioms are processed in Persian from structural and semantic viewpoint. At that time, this work was considered the first ERP experiment conducted on Persian language. This was an encouraging starting point for her.

Then, she entered the Erasmus Mundus program of IDEALAB (International Doctorate on Experimental Approaches to Language and Brain) which was joint among five universities of Groningen (in the Netherlands), Potsdam (in Germany), Trento (in Italy), Newcastle (in England), and Macquarie (in Australia). Although she selected Potsdam and Groningen as the two main universities to conduct the experiments, she seized any chance to visit the labs and undergo training in the other three universities through the great summer and winter schools organized by IDEALAB. She was also trained in advanced statistical analysis, thanks to the extensive training provided in Potsdam. Later, She conducted a set of psycholinguistic reading experiments on healthy population of Persians (both in Iran and in Germany) using different methodologies like self-paced reading and eye-tracking. She investigated the two competing accounts of memory and expectation in resolving long-distance dependencies. The results of these experiments formed the current dissertation.

In the last year of her doctoral studies, she started collaborating with ANT Neuro in a speech mapping project using navigated Transcranial Magnetic Brain Stimulation (TMS) which is a novel technology to map the eloquent areas of the brain (e.g., in tumor patients). At the time of publishing the current dissertation, she is the project manager for validating the neuronavigation system to be used for both research and clinical purposes in various Neurolinguistic studies.