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Eye-Tracking Analysis of the Processing of Turkish Complex Sentences with Wh Phrases*

Ne-Sözcüğü İçeren Türkçe Karmaşık Tümcelerin İşlemlenmesinin Göz-İzleme Yöntemiyle İncelenmesi

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Abstract

This study analyses the processing of complex sentences with displaced wh-phrases in Turkish via the application of eye-tracking. The first experiment is conducted with wh-argument 'kim-E' (*to whom*), while the second experiment is conducted with wh-argument 'when' (*ne zaman*). The study aimed at pointing out whether the Turkish processor makes an initial syntactic analysis during reading sentences with long-distance dependencies, which is one of the major tenets of garden – path "model of sentence processing, or makes use of the semantic and syntactic information provided by the verb simultaneously due to the head final structure of Turkish being affected with the type of the embedded verb. Also, the study aimed at figuring out the effect of the linear and structural distance between the default position of a wh-phrase and its scrambled position, and also the LF (logical form) position in processing. Whether linear distance or structural distance is effective in processing long distance dependencies (filler – gap) formed in complex sentences with displaced wh-phrases in Turkish is sought. It has been found that the Turkish processor does not build an initial syntactic structure during the first pass reading of the sentence, which is majorly interpreted through the 'first fixation recordings' on embedded verb regions of the sentences, and thus, makes use of the verbal information in a parallel fashion. Also, the linear distance seems to be a major determinant during processing prevailing the structural distance in forming long distance filler gap dependency, which is also understood by the 'regressive saccadic patterns' made from the end of the sentences to the wh-phrase region.

Keywords: Sentence Processing, Wh-Phrases, Eye-tracking, Filler-Gap Dependency, Ambiguity.

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Öz

Bu çalışmada, ne-öbeği bulunan Türkçe karmaşık tümcelerin işlemlenmesi göz-izleme yöntemiyle incelenmiştir. Türkçe'deki işlemleme stratejileri, altmış katılımcıya uygulanan ve iki aşamada gerçekleştirilen iki deneyle analiz edilmiştir. 1. deney ne-katılanı olan 'kim-E' ile uygulanırken, 2. deney ne-eklentisi olan 'ne zaman' ile uygulanmıştır. Çalışma, Türkçe işleyicinin uzun-mesafeli bağ barındıran tümceleri işlerken, 'garden-path' modelinin önemli ilkelerinden biri olan öncül bir sözdizimsel analiz mi yaptığını, ya da Türkçe'nin baş-son yapısına bağlı olarak eylem tarafından sağlanan anlambilimsel ve sözdizimsel bilginin birlikte işlendiği ve yardımcı eylemin türü dolayısıyla etkilenen bir işlemleme mi yaptığını ortaya koymayı amaçlamaktadır. Çalışmanın bir diğer amacı da, bir ne-öbeğinin temel pozisyonuyla çalkalandığı pozisyon ve mantıksal formdaki (LF) pozisyonu arasındaki çizgisel ya da yapısal mesafenin işlemlemeye etkisini saptamaktır. Ne-öbeği içeren Türkçe karmaşık tümce yapısındaki uzun mesafeli bağıntıların (yer tutucu – boşluk) işlemlenmesinde çizgisel mesafenin mi, yoksa yapısal mesafenin mi etkin rol oynadığı araştırılmıştır. Türkçe işleyicinin tümcenin ilk okuması sırasında, tümcelerin yardımcı eylem bölgesi üzerinde kaydedilen 'ilk sabitleme süreleri'nin incelenmesiyle, öncül bir sözdizimsel yapı oluşturmadığı fakat eylem kaynaklı bilgiyi paralel bir biçimde kullandığı bulunmuştur. Ayrıca, tümcelerin sonundan ne-öbeği bölgesine yapılan 'geriye dönük göz hareketleri'nin analizi yoluyla, çizgisel mesafenin yapısal mesafeye üstün gelerek uzun mesafeli yertutucu – boşluk bağıntısının işlemlenmesi sırasında ana belirleyici olduğu gözlenmiştir.

Anahtar Sözcükler

Tümce işleme, Ne-öbekleri, Göz-izleme, Yertutucu-Boşluk Bağı, Anlam bulanıklığı.

Introduction

Sentence processing research is interested in how language users construct the exact syntactic structure to form sentences. (van Gompel, 2006). Computing the syntactic structure of a sentence, which is central to thematic role assignment, is named as parsing, in which, first, the syntactic category of each unit in the sentence should be specified, and second, the specified categories should be combined together into phrases. Research on sentence processing generally focused on syntactic ambiguities providing an insight for exploring the mechanisms of the sentence processor (van Gompel, 2006). In terms of studying the ambiguity resolution, Harley (2005) states that it is very difficult to recognize what is happening during sentence processing if there is no obstacle for the parser and it is because of this, that most research on how parsing is accomplished have been conducted on syntactically ambiguous sentences.

There are two major competing theories in psycholinguistics, attempting to explain the sentence processing strategies. One is a group of autonomous models in which the processing is thought to occur in a two-stage procedure. In two-stage models, the initial stage uses just the syntactic information to build a syntactic representation of the sentence. The other one is the interactive model in which the processing is realized in a single-stage basis. In one-stage model, the syntactic representation is structured through a process in which syntactic and semantic information is merged (Harley, 2005). Rayner

et al. (1983) claim that a possible thematic processor has no effect in the initial analysis, but during reanalysis. The model consists of two modules as the syntactic and thematic ones. The syntactic processor forms a constituent structure representation, which then integrates the required semantic roles by the help of the thematic processor by taking into consideration the real-world knowledge. As cited in Crocker (1999), it is among the key assumptions of Frazier (1984) that the initial decisions are operated purely syntactically, lacking the influence of thematic processor. Through a general look on the serial (garden-path model) and parallel (constraint-based) models of parsing, it can be summarized that; in serial two-stage models, syntactic and semantic information used for processing are divided into two separate levels. While only syntactic information is used in the initial stage, in the second stage, semantic information is used. However, in parallel models, all the information (syntactic and non-syntactic) is used at the same time in order to create alternative representations.

Processing Filler – Gap Dependencies

Hawkins (1999) states, following Fodor (1978), that in psycholinguistics the 'moved element'(wh-phrases in questions) and the 'traces' (the positions where the wh-phrase is originally generated and co-indexed with the moved element) are represented as the '*filler*' and the '*gap*' respectively; and much of the problem related to the processing strategies of the dependencies between these units during parsing have not yet been settled in psycholinguistic endeavor in a full-fledged manner. What are the points of consensus are the facts that first, this type of structures (filler-gap dependencies) is difficult to process; and second, the human language processor gets an intense processing load and produces a large amount of exertion during forming the relation between the filler (the moved element) and the gap (the trace left behind).

In psycholinguistic literature, it is probable to state that garden path theories and constraint-satisfaction approaches try to interpret dependencies in wh-phrase and relative clause constructions. Pickering and van Gompel (2006) state that garden-path theory introduced the 'Active-Filler Strategy/Hypothesis' or 'The Minimal Chain Principle' to explain unbounded dependencies while 'thematic role' or 'lexically driven approaches', as described above, are stated to be alternative approaches for 'active filler strategy' in psycholinguistic literature by Aoshima et al. (2004). The thematically driven approaches necessitate the filler-gap dependency to be formed with an argument's need to be associated with a predicate in terms of thematic role satisfaction, and also directly related with case assignment necessity. Aoshima et al. (2004) state that in head-initial languages, 'active filler hypothesis', 'verb-driven' or 'constraint-driven' accounts seem to be compatible with characteristic of the language, and in a head-final language like Japanese, all these accounts may reflect different forecasts in long-distance dependencies. Also, Stowe (1986) states that if how people assign the moved wh-element to a gap position is understood fundamental questions about how humans process language can be answered.

The issue of whether the misanalysis of syntactically ambiguous sentences is the product of an earlier syntactic attachment procedure like 'minimal attachment' which are

consistent with 'garden-path model' as asserted by Frazier and Rayner (1982) or whether verb biases affect processing very rapidly and thus are used during initial processing, makes the problem to be discussed for Turkish complex sentence structure with ambiguity at the mercy of verb-final order of Turkish and seems to provide valuable outcomes for the arguments in sentence processing through long distance dependency.

Besides the endeavor to understand how the chain between the moved/scrambled items and their gaps are formed, which factors are more effective during processing these items are discussed in the framework of the 'syntactic distance' (SDH) and 'linear distance' (LDH) hypotheses. The issue of whether structural or linear distance is at work is majorly discussed over the processing divergence on subject and object relative clauses. Linear distance hypothesis formulated by O'Grady et al. (2003) indicates that the difficulty of a relative clause is determined by the number of elements, which intervene between the gap and the head, while the structural distance hypothesis, which is also formulated in the same study states that it is the depth of the gap in relation to the relativized item determining the difficulty in relative clause processing. It is also possible to observe studies on Turkish subject and object relative clause processing.

Head-final languages may provide an availability in explaining how human language processor works during filler-gap dependency resolution. It is a universal tendency to test the hypotheses on language processing mechanisms on languages other than English, which may either have head-initial or head-final nature, or some other language-specific mechanisms to mark question formation with wh-constructions such as, Ng (2008) on Chinese; Frazier (1987), Kaan (1997) on Dutch; Schlesewsky et al. (2000) on German; Rado (1999) on Hungarian, De Vincenzi (1991) on Italian; Miyamoto and Takahashi (2002, 2004) on Japanese; Sekerina (2003) for Russian, and etc. Aoshima et al. (2004) indicate that a head-final language like Japanese may be a good source of research for testing the approaches which try to define the mechanisms at work in long-distance dependencies since each approach (active filler, verb-driven and full-constraint driven) may provide different results while all these approaches make similar estimations for verb-initial languages like English. In that respect, Turkish, which allows scrambling of NPs and wh-phrases to a considerable degree may also provide outcomes for understanding human language parsing mechanism. While Turkish is a head-final language like Japanese, it lacks any question particle to specify the interrogative scope of the wh-phrase in wh-question formation, which is a major property of Japanese (Aoshima et al. 2004; Miyamoto and Takahashi, 2002; 2004; Ueno and Kluender, 2003). This means that there may be another possibility for challenging the approaches dominating the field, both being a head-final and lacking a question particle (Q-particle) language.

While the wh-question formation in Turkish has been studied by many researchers through a formal framework (Akar, 1990, 2000; Görgülü, 2006; İşsever, 2003; Kornfilt, 1996, 2003; Kural, 1992; Özsoy, 1996, 2009; Uzun, 2000) not much work has been done on the processing mechanisms during processing sentences including scrambled/moved wh-phrases.

Aim of the Study

Although the wh-phrases in Turkish have been studied through a formal framework intensively, the psycholinguistic literature on Turkish lacks the study of sentence processing with displaced wh-phrases. This study tries to examine the processing of complex sentences with displaced wh-phrases in terms of both the parsing strategies of the Turkish processor and the possible effect of the linear or structural distance between the filler and the gap of the displaced wh-phrase.

The present study aims at pointing out how Turkish complex sentences with displaced wh-phrases are processed in general. Specifically, the study seeks answers for the following two questions;

1. How are complex sentences with displaced wh-phrases are processed in Turkish? Does the Turkish processor make an initial syntactic parsing or do the syntactic and semantic information provided by the verb assign the scope relations together?
2. Is it the linear distance or the structural distance between the displaced wh-phrase and its gap position in ambiguous complex sentences, which affects the processing strategies of the Turkish parser?

Method of the Study

Two different eye-tracking experiments have been conducted in order to get the reading data of 80 target sentences in total. The wh-phrase in the first experiment is 'kim-E' (*to whom*) which is a wh-argument, while the wh-phrase used in the second experiment is 'ne zaman' (*when*) which is a wh-adjunct. Each experiment included 40 target sentences with wh-phrases in two different word orders (*order1 = subject1 – wh-phrase – subject2 – object – embedded verb – main verb; order 2 = subject1 – subject2 – wh-phrase – object – embedded verb – main verb*); and two different embedded verb types (*transitive* and *ditransitive*[1]). Each target sentence in the experiment is biased with interrogative and declarative contexts in order to make readers interpret both of the readings for ambiguous sentences. Each experiment included eight of sentence types, each of which condition is composed of five different sentences, making a total of 40 target sentences in each experiment.

In order to evaluate whether the Turkish processor makes an initial syntactic analysis during reading the complex sentences, the 'first fixation duration' records were analyzed on each area of interest (AOI). Each word in the sentence has been specified as an area of interest. New visual information from the text is just encoded during this phase of 'fixation'. 200 – 250 ms duration is stated to be a typical duration for a fixation. The

1 The term 'ditransitive' in the present study has been used in order to designate the 'double-object' verbs in Turkish, which allow two DPs, or a DP and a CP object in its argument structure. The use of the term 'ditransitive' does not offer any suggestions on the merge of objects in Turkish in terms of the debate on the universal order and the hierarchy of direct objects (DOs) and indirect objects (IOs).

duration of fixations, besides the saccadic movement of the eyes, directly reflect the reading processes to be executed easily or with difficulty (Garrod, 2006). 'First fixation duration' relates the duration of the first fixation on an area of interest (Meseguer et al., 2002; Rayner and Pollatsek, 2006). Frenck-Mestre (2005) indicates that it is possible to distinguish first pass measures (which can include first fixation durations) from second pass measures. With the data on first pass measures, the initial parsing preferences may be derived, while with second pass measures, information on the re-analysis strategies of the parser can be gathered. In order to figure out if the Turkish processor makes an initial syntactic analysis or not, 'first fixation durations' on the AOIs have been evaluated.

Besides the fixation data, the data gathered through the 'regressive saccade frequencies' between the specified AOIs have been used to answer which type of distance (structural or linear) is important in processing complex sentence with displaced wh-phrases in Turkish. Rayner and Pollatsek (2006) state that when text is difficult, readers tend to move their eyes back in the text. These backward movements are called regressions. Regressive saccades are the instances of the readers' misanalysis of what they have read and aim at re-reading the text to recover the suitable analysis (Just and Carpenter, 1980). Rayner and Pollatsek (1989) state that the reason that the readers make regressive saccades stem from comprehension difficulty, and attempts to solve the comprehension problem, also Frenck-Mestre (2005) states that the pattern of regressions may give useful information on the difficulty of text processing. It is proposed by Frazier and Rayner (1982) that when readers come up with a region that disambiguates a former problem in the sentence, they often regress back to the region which causes a failure in comprehension. Besides Frazier and Rayner (1982), Mitchell et al. (2008) assert that there is solid evidence indicating that regressive eye-movements are related to problems in syntactic problems. In the light of the information on the background literature, the regressive saccade frequencies from main verb to wh-phrase region in the target sentences have been analyzed in order to answer the reasons of the processing difficulty if it stems from the structural or linear distance between the gap position of the displaced wh-phrase and its actual realization (the wh-filler).

The Procedure of the Experiments

The experiments were run on Tobii T120 eye-tracker, software, version 3.1.3. The first experiment was conducted in two phases with 30 native speakers of Turkish. The participants were undergraduates of Hacettepe University. The participants were told to read what was appeared on the screen to comprehend. In the first experiment, the participants saw two sentences on the same screen for each time. The above sentence was the biasing context sentence (either interrogative or declarative biasing) and the below sentence was the target sentence including the wh-word. Each time the participants pressed the space button, a biasing context and the target sentence appeared on the screen. The participants all had normal or corrected to normal vision. The second experiment has been accomplished in two different sessions. None of the participants in the first

experiment took part for the second one. The participants in the second experiments made silent reading of 40 target and 40 filler sentences following the same procedures in the first experiment.

The Data Collection Set

The first experiment included 60 items (40 target sentences and 20 filler sentences). The 40 target sentences are composed of eight conditions. The variables of the first experiment are; two different word orders (*order.1 | subject.1 – wh-word – subject.2 – object – embedded verb – main verb; order.2 | subject.1 – subject.2 – wh-word – object – embedded verb – main verb*) two different embedded verb types (*transitive and ditransitive*) and two different biasing contexts (*interrogative and declarative*).

Each condition included five different sentences, which make a total of 40 target sentences. Each sentence in the same condition differ only in terms of the embedded verbs, main verbs, subjects and the objects used, but the order, the nature of the embedded verb (transitivity or ditransitivity) and the biasing context (interrogative, declarative) are the same which, thus increases the statistical validity by enhancing the number of the items to be calculated.

The two word orders used in the first experiment are given below:

Order.1 | subject.1 – wh-word – subject.2 – object – embedded verb – main verb

Order.2 | subject.1 – subject.2 – wh-word – object – embedded verb – main verb

The two embedded verbs used in the first experiment are given below:

transitive embedded verbs: '*görmek*' (to see), '*kırmak*' (to break), '*değiştirmek*' (to change), '*kaybetmek*' (to lose), '*bitirmek*' (to finish)

ditransitive embedded verbs: '*vermek*' (to give), '*götürmek*' (to take), '*açıklamak*' (to explain), '*göndermek*' (to send, to transmit), '*yollamak*' (to send)

The main verbs used in the experiment are all ditransitive since each item is a complex sentence (composed of two clauses) and are as follow; *söylemek* (to say), *anlatmak* (to tell), *bildirmek* (to notify), *hatırlatmak* (to remind), *duyurmak* (to announce). Each main verb is used with each of the embedded verb type (transitive and ditransitive), and with each biasing context type (interrogative and declarative), and with two different word orders, thus making eight different conditions each of which has been formed with five different main verbs, making a total of 40 trials as the target sentences.

The organization of the data collection set of the second experiment is all the same with the first experiment except the type of the wh-word. The wh-word used in the second

experiment is a wh-adjunct *ne zaman* (when). Using a wh-adjunct instead of a wh-argument in the second experiment provides understanding the behavior of the processing mechanism when the argument structure of the embedded verb and the nature of the wh-word are considered. Wh-adjunct does not refer to any entity that exists in the sub-categorization frame of any potential licenser (predicate) and thus helps pointing out the potential influence of the embedded verb type and wh-word interaction during processing, if the processing strategies of the parser has been affected by the sub-categorization of the predicate, and thus a possible tendency to parse the ambiguous complex structure by the help of the predicate, indicating a verb-driven parsing strategy. The items set of the second experiment is composed of 80 items (40 target sentences and 40 filler sentences). The 40 target sentences (trials) are composed of eight conditions as same as the first experiment.

Each condition included five different sentences, which make a total of 40 target sentences like the ones in the first experiment. In order to provide the coherence among variables, all the embedded verbs and main verbs in the first experiment also used for the second experiment. Thus, only variable that distinguishes the first and second experiments is the type of the wh-word.

> The two embedded verbs used in the second experiment are given below:
>
> transitive embedded verbs: '*görmek*' (to see), '*kırmak*' (to break), '*değiştirmek*' (to change), '*kaybetmek*' (to lose), '*bitirmek*' (to finish)
>
> ditransitive embedded verbs: '*vermek*' (to give), '*götürmek*' (to take), '*açıklamak*' (to explain), '*göndermek*' (to send, to transmit), '*yollamak*' (to send)

The main verbs used in the second experiment are *söylemek* (to say), *anlatmak* (to tell), *bildirmek* (to notify), *hatırlatmak* (to remind), *duyurmak* (to announce). Each main verb is used with each of the embedded verb type and with each biasing context type and in two different word orders thus making eight different conditions each of which has been formed with five different main verbs, making a total of 40 trials as the target sentences.

Findings and Discussion

In order to answer the first research question which is inquiring whether the Turkish processor makes an initial syntactic parsing or the syntactic and semantic information provided by the verb assign the scope relations together, the 'first fixation durations' on the embedded verb in condition five and six on the one hand, and conditions seven and eight on the other are compared. The rationale for this comparison is that Turkish is a verb-final language with a flexible order for case-marked DPs. This makes it for the

parser impossible to build an initial syntactic analysis before coming up with the first verb in the sentence. The place of the wh-word in these four conditions is the same: following the embedded clause subject DP. If the parser built an initial syntactic analysis to process ambiguous complex sentences in Turkish, it could have been expected that the processor to have trouble after coming up with the first (embedded) verb in the sentence according to the type of the verb. Conditions five and six produce ungrammatical sentences due to the transitivity of the embedded verb. The displaced wh-argument is inside the embedded clause in these conditions, the embedded clause also host another DP as the object in the same clause and as a result of this, the embedded clause verb should be ditransitive to host two object DPs in the same clause (one is the wh-argument to get case and thematic role and the other is the already existing DP object). Sentence 3 given below is an example of condition five and six sentences in the first experiment:

3. Cemal	Demet'in	kime	kitabı	gördüğünü	söyledi
Cemal-nom	Demet-gen	who-dat	book-acc	see-pst-ind-3rd	say-pst-3rd

Since the 'first fixation durations' on the items under discussion should reflect the immediate initial analysis, it is needed to check if there is a divergence on the 'first fixation durations' on the embedded verb which could either be problematic for the processor as condition five and six sentences would necessitate, or it couldn't cause any trouble for the parser as in the case in condition seven and eight sentences, which have been constructed with ditransitive embedded verbs and create 'double' interpretations (either interrogative [Q] or declarative [D]) as seen in sentence 4 below:

4. Mert	Ezgi'nin	kime	mektubu	gönderdiğini	hatırlattı
Mert-Nom	Ezgi-Gen	who-Dat	letter-Acc	send-Pst-Ind-3rd	remind-Pst-3rd

In conditions five, six, seven, and eight sentences, when the word order is considered, it is not possible for the parser to create a structure until the accusative marked DP object is read. If the parser builds an immediate syntactic analysis of the sentence, it should expect for a complex sentence after reading the following order; [Mert Ezgi'nin kime mektubu _____ '*Mert-Nom Ezgi-Gen who-Dat letter-Acc* _____'] which, in a parallel fashion, dictates the existence of a ditransitive embedded verb following the accusative marked DP (*mektup-Acc*). So, this could mean that if the parser is building an immediate syntactic structure to process these types of sentences, the 'first fixation durations' on the embedded verb should show divergence when conditions five, six and conditions seven, eight are compared since the former ones are formed with transitive embedded verbs while the latter ones are constructed with ditransitive embedded verbs. An obstruction, or a difficulty is expected on the 'first fixation durations' on the embedded verb region of condition five and six sentences in comparison to condition seven and eight sentences.

Table 1- First fixation durations in the fifth condition sentences on the embedded verb region

Experiment.1 – First fixation durations	
Order.2 /**s1 – s2 – wh – obj – ev – mv**/ Embedded verb type: **Transitive** / Context: **Interrogative [Q]**	
Condition.5	**Ev**
1	5,59
2	7,35
3	5,92
4	5,75
5	5,94
Total	**30,55**

Table 2- First fixation durations in the sixth condition sentences on the embedded verb region

Experiment.1 – First fixation durations	
Order.2 /**s1 – s2 – wh – obj – ev – mv**/ Embedded verb type: **Transitive** / Context: **Declarative [D]**	
Condition.6	**Ev**
1	6,63
2	7,68
3	5,97
4	5,56
5	6,26
Total	**32,10**

Table 3- First fixation durations in the seventh condition sentences on the embedded verb region

Experiment.1 – First fixation durations	
Order.2 /**s1 – s2 – wh – obj – ev – mv**/ Embedded verb type: **Ditransitive** / Context: **Interrogative [Q]**	
Condition.7	**Ev**
1	6,16
2	6,18
3	5,69
4	5,56
5	5,83
Total	**29,42**

Table 4- First fixation durations in the eighth condition sentences on the embedded verb region

Experiment.1 – First fixation durations	
Order.2 /**s1 – s2 – wh – obj – ev – mv**/ Embedded verb type: **Ditransitive** / Context: **Declarative [D]**	
Condition.8	**Ev**
1	6,24
2	5,40
3	5,41
4	5,72
5	6,72
Total	**29,49**

When the results on 'first fixation data' observed on the ditransitive embedded verb regions are compared, it is seen that the difference between these two values are statistically non-significant (*the two-tailed P value equals 0.1798*). This is clearly an indication of a non – preference for an initial syntactic analysis of the structure, which is one of the major components of garden – path theory in processing sentences with fronted fillers. Also, this may relate that Turkish complex sentences with displaced wh-phrases are processed – mostly due to the verb final property of Turkish – in a parallel fashion which considers the syntactic and semantic information provided by the embedded and main verbs respectively, at the end of each sentence, which is observed through the regression frequencies from the end of the sentences to the wh-phrase region, diverging according to the location of the wh-phrase (the farther it is from the main verb to more regressive saccades are obtained), and the analysis of these types of regressions will be given while answering the second research question of the present study. Although the structure makes it possible for the processor to build a preferred syntactic analysis, before coming up with the first verb in the sentence, the 'first fixation analysis' on the resolution region does not indicate that an initial syntactic analysis is made through the initial stage of parsing. Also, when the 'first fixation durations' on the embedded verb regions of the first word order sentences are compared (conditions 1, 2, 3, and 4) due to embedded verb type difference, a divergence has not been observed when the parser comes up with a transitive verb, which in total is a supportive finding for an absence of initial syntactic parsing strategy. Due to the verb final order of Turkish, the processor should wait for constructing the subcategorization information until the end of the sentence since in a complex sentence in Turkish the final positions are occupied by the embedded and main verbs respectively. Since the processor does not make an initial structure building, even though it had the chance by the help of the accusative marked object before the embedded verb, the only way of forming the syntactic and semantic construction is after reaching the end of the sentence and making regressive saccades to resolve the ambiguity. In that

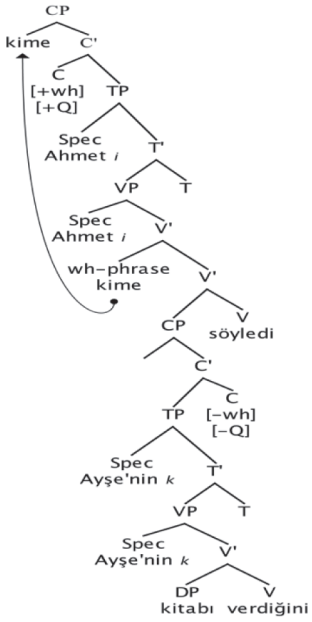
respect, the place of the wh-phrase plays the major role above all options. In both of the experiments, the frequency of main verb to wh-phrase regressive saccades is higher in the first word order (wh-phrase is located before the embedded clause subject) than the ones in the second word order (wh-phrase is located inside the embedded clause) as shown respectively:

1st experiment:
main verb to wh-phrase regression pattern in the 1st word order in total: 135
main verb to wh-phrase regression pattern in the 2nd word order in total: 68
(the two-tailed P value equals 0.000)

2nd experiment:
main verb to wh-phrase regression pattern in the 1st word order in total: 111
main verb to wh-phrase regression pattern in the 2nd word order in total: 47
(the two-tailed P value equals 0.000)

The second research question asks for an answer whether the linear or structural distance between the gap of the displaced wh-phrase and its filler is a major determinant causing a processing difficulty in Turkish. To find an answer to this question, the regressive saccade frequencies between the main verb and the wh-phrase regions are taken into consideration in conditions three and four on one hand, and conditions seven and eight on the other. The reasons for choosing these conditions are that, all these four conditions create double readings (interrogative and declarative) in both of the experiments, all of them have been formed with ditransitive embedded verbs, while the only diverging variable between these conditions is the place of the wh-phrase. In conditions three and four, the wh-phrase is located before the embedded clause subject, while in the seventh and eighth conditions it is placed inside the embedded clause, thus making it possible to assess the effect of the linear placement of the wh-filler in a comparative manner along with the structural difference. The two samples of sentences belonging to these four conditions are given below in tree diagrams (Condition three is biased with interrogative, while condition four is biased with declarative; condition seven is biased with interrogative while condition eight is biased with declarative). Sentence 5 is an instance of condition three and four sentences. The wh-phrase precedes the embedded clause subject, and the embedded verb is ditransitive, while sentence 6 exemplifies condition seven and eight sentences, in which the wh-phrase is located inside the embedded clause formed with a ditransitive embedded verb. In condition three and four sentences, in order to form a matrix question reading, the wh-phrase moves to Spec-CP at LF (logical form), and base generated position should be the pre-initial position of the main verb which creates a long linear distance between the gap and the filler. But this constructs a syntactically shorter distance, since the wh-phrase did not originate inside the deeply embedded clause as seen

in the tree diagram 1, below. So, it may be asserted that, the linear distance between the gap and the filler is longer than the structural distance between the two.



Tree diagram 1 – Sample sentence belonging to the third and fourth conditions in the first experiment

5. Spec CP*i* [Ahmet [kime *i* Ayşe'nin kitabı verdiğini] *ti* söyledi]

LF

Ahmet-nom who-dat Ayşe-gen book-acc give-3rd-sing-ind say-3rd-sing-pst

'To whom did Ahmet say that Ayşe gave the book?'

'Ahmet said to whom Ayşe gave the book.'

On the other hand, condition seven and eight sentences are also capable of forming interrogative sentences, in which the wh-phrase originates inside the embedded clause and then moves to the Spec-CP at LF. This creates a contradiction with condition three and four sentences. In condition seven and eight sentences, the linear distance between the gap and the filler is shorter than the one in condition three and four sentences. Moreover, the structural distance between the gap and the filler is longer in condition seven and eight sentences than as it is in condition three and four sentences as seen in sentence 6 and the tree diagram 2 given below:

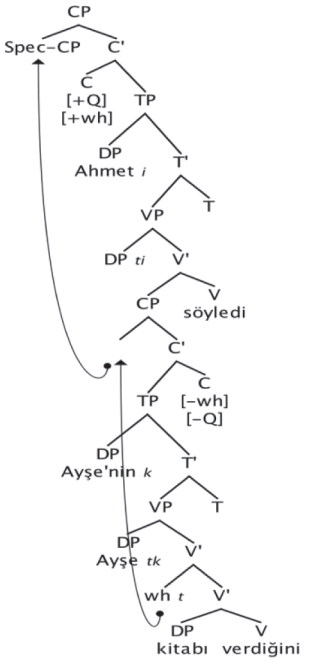
6. Spec CP*i* [Ahmet [Ayşe'nin kime *i* kitabı *ti* verdiğini] söyledi]

LF

Ahmet-nom Ayşe-gen who-dat book-acc give-3rd-sing-ind say-3rd-sing-pst

'To whom did Ahmet say that Ayşe gave the book?'

'Ahmet said to whom Ayşe gave the book.'



Tree diagram 2 – Sample sentence belonging to the seventh and eighth conditions in the first experiment

The difference in the regressive saccadic eye movement frequencies between the two sentence types with different linear orders according to the place of the wh-phrase and also with different structural organizations show that when the linear distance between the filler and the gap is longer (condition three and four sentences) the regressive saccadic movements increase dramatically, although the structural distance for the fronted wh-phrase in order to reach the Spec-CP at LF is shorter, as shown below:

1st experiment

main verb to wh-phrase regression pattern in conditions 3 and 4 (1st word order): 67

main verb to wh-phrase regression pattern in conditions 7 and 8 (2nd word order): 39

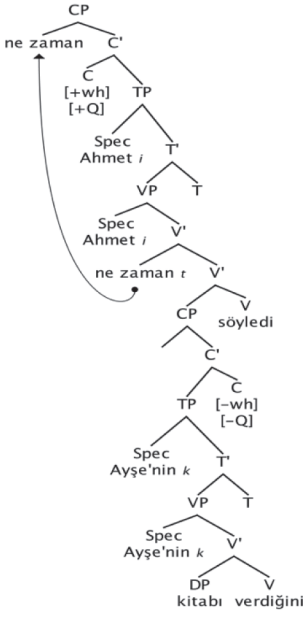
(the two-tailed P value equals 0.001)

On the contrary, when the linear distance between the filler and the gap is shorter as in the 2nd word order sentences given in conditions seven and eight, having a longer structural distance in a parallel fashion, the regressive saccade frequencies decrease in a significant manner, which denotes that it is the linear distance between the fronted item and the gap position which affects the processing of complex sentence structure with fronted wh-phrases in Turkish.

The same outcome is also gathered through the analysis of main verb to wh-phrase regression patterns in the second experiment as seen below:

2nd experiment:
main verb to wh-phrase regression pattern in conditions 3 and 4 (1st word order): 57
main verb to wh-phrase regression pattern in conditions 7 and 8 (2nd word order): 30
(the two-tailed P value equals 0.010)

The tree diagrams 3 and 4 below indicate the possible gap positions and the landing sites of the wh-phrases. Although the distance between the gap positions and the fillers seem to be similar syntactically, the regression frequencies increase dramatically when the wh-fillers landed farther from the potential gap positions (pre – verbal positions).



Tree diagram 3 – Sample sentence belonging to the third and fourth conditions in the second experiment

7. Spec CP*i* [Ahmet ne zaman *i* [Ayşe'nin kitabı verdiğini] *ti* söyledi]

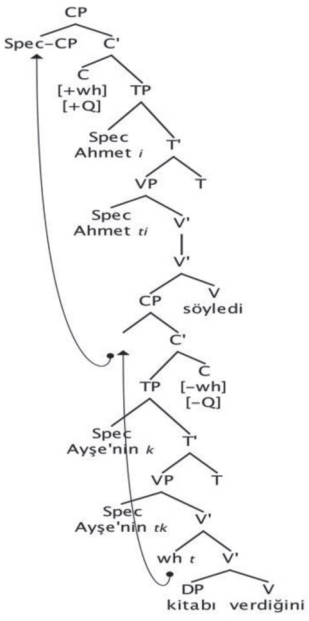
LF

Ahmet-nom when Ayşe-gen book-acc give-3rd-sing-ind say-3rd-sing-pst

'When did Ahmet say that Ayşe gave the book?'

'Ahmet said when Ayşe gave the book.'

Both an interrogative and a declarative interpretation can be derived as through the sentence given above. In order to construct a matrix question reading the wh-phrase moves to Spec-CP of the main clause at LF, but in order to make a declarative reading, remains in the canonical position. The interrogative interpretation provides a longer linear and a shorter syntactic distance when it is compared with condition seven and eight sentences as given below.



Tree diagram 4 – Sample sentence belonging to the seventh and eighth conditions in the second experiment

8. Spec CP*i* [Ahmet [Ayşe'nin ne zaman *i* kitabı *ti* verdiğini] söyledi]

LF

Ahmet-nom Ayşe-gen when book-acc give-3rd-sing-ind say-3rd-sing-pst

'When did Ahmet say that Ayşe gave the book?'

'Ahmet said when Ayşe gave the book.'

The particiapants' having more difficulty during processing condition three and four sentences (shorter syntactic, longer linear distance between the gap and the fillller positions) than condition seven and eight sentences (longer syntactic, shorter linear distance) show that, as it has been proposed for the first experiment, the processing of ambiguous complex sentences with fronted wh-phrases are based on the linear distance of the gap and the filler positions. In that regard the importance of the place of the verbs, which are the potential gap sites for the wh-phrases and the derived interpretations, which specify the movement of the wh-phrase at LF, seem to be highly important for both wh-adjuntcs and wh-arguments.

The particiapants' having more difficulty during processing condition three and four sentences (shorter structural, longer linear distance between the gap and the fillller positions) than condition seven and eight sentences (longer structural, shorter linear distance) show that, as it has also been proposed throughout the results of the first experiment, the processing of ambiguous complex sentences with fronted wh-phrases are based on the linear distance between the gap and the filler positions. In this regard, the importance of the place of the verbs, which are the potential gap sites for the wh-phrases and the derived interpretations, specifying the movement of the wh-phrase at LF, seem to be highly important for processing complex sentences with ambiguity formed with both wh-adjuntcs and wh-arguments.

Conclusion

The present study tries to discover the processing strategies carried out during the processing of ambiguous complex sentences with displaced wh-phrases in Turkish. Through a very general outlook on the findings, it can be stated that the Turkish parser does not make an initial syntactic parsing during on – line processing of the complex sentence structure, but makes use of the verbal information encoded in the embedded verb and main verb regions. The examination of the 'first fixation durations' indicates that when the readers come up with the accusative marked object DP in the sentence, they do not build an initial syntactic analysis. This finding seems to relate a verb – based account of processing for Turkish, at least during the initial stage of sentence reading. This seems to be also in accordance with the word order of Turkish. Turkish is verb final, and even if the accusative marked DP object in the related order could be an indicator of a complex structure, the Turkish parser seems to make use of the verbal information in the initial stage of parsing. The outcomes emphasize the role of the place of the wh-phrase in complex sentences in overall processing strategies; but it looks clear that during the first pass phase of reading, the Turkish parser uses the syntactic and semantic informational constraints brought by the first verb (the embedded verb) in order to build a structure to interpret the sentence.

Moreover, the results the first experiment show that, in the processing of Turkish complex sentences with displaced wh-phrases, the linear distance between the fronted wh-phrase and its potential gap position is more important than the structural distance between the wh-phrase and the gap position. The analysis of the regressive saccade frequencies, support that linear distance is important in processing. Condition 3 and 4 sentences have double interpretations (either interrogative [Q] or declarative [D]), the wh-phrase is located before the embedded clause subject, and the embedded verb is ditransitive. Condition 7 and 8 sentences have also double interpretations, the wh-phrase is located inside the embedded clause and the embedded verb is ditransitive. The only difference between these two types of sentences is the place of the wh-phrase. In condition 3, and 4 sentences, the linear distance between the wh-phrase and its gap position is longer than the one in condition 7 and 8 sentences. On the contrary, the linear distance is shorter in condition 7 and 8 sentences while the structural distance is longer than the one in condition 3 and 4 sentences. If a linear distance hypothesis had a major role in processing, the results could have indicated a processing difficulty in condition 3 and 4 sentences. The outcomes relate that the regressive saccade frequency from main verb to wh-word in condition 3 and 4 sentences (having longer linear distance – shorter structural distance) outnumbers the same regressive saccade frequencies in condition 7 and 8 sentences (having shorter linear distance – longer linear distance) which is a clear indication of a linear distance hypothesis to be at work in processing fronted wh-fillers in complex sentences with ambiguity in Turkish. The same effect has been observed in the second experiment. Through a general look at the main verb to wh-phrase regression frequencies comparing the word order alteration in the second experiment, it is seen that the regressive saccade frequencies decrease in the second word order in which the wh-phrase in inside the embedded clause (linearly closer to the first verb in the sentence than the location in the first word order). This supports the findings gathered in the first experiment implemented with a fronted wh-argument indicating the importance of linear distance between the filler and the gap above structural distance in the processing of complex sentences with fronted wh-phrases in Turkish. The closer the wh-phrase to the first verb (embedded verb) in the sentence, the easier it is to be processed. This outcome also seems to be in parallel with Aoshima et al. (2004) reporting that Japanese (an SOV language like Turkish) readers prefer to interpret a fronted wh-filler within an embedded clause, and further indicated that the wh-phrase is related to the first verb, that readers come up with in the sentence. It may be interpreted throughout the findings of the present study that, the Turkish readers also try to relate the scrambled wh-filler with the first verb in the linear order, which is the verb of the embedded clause due to the word order of Turkish. Since both of the sentence types used in the present study include wh-phrases preceding the embedded and main verbs, it is the difference in the processing loads recorded among these two word order types making it possible to propose that the closer the wh-filler to the first verb in the sentence, the easier it is to be processed. Also, the finding relating a non-preference for an initial syntactic parsing for the type of sentences in the present study creates a parallel viewpoint on the matter. The parser takes into consideration the linear distance into consideration while

licensing the wh-filler with the gap. This must also be due to the abundance of the items between the displaced wh-filler and the first verb in the sentence since it means that the farther the wh-filler is placed to the leftmost location in the sentence, the more elements occur between the filler and the gap position causing a burden for the working memory load, which resembles the findings of Ueno and Kluender (2003) reporting that both filler-gap dependencies and wh-Q dependencies evoke anterior negativity (R)AN in the form of slow potentials which has been hypothesized to be the result of working memory load caused by the dependency between a wh-unit and its related Q-particle resembling the situation in wh-movement languages in which the parser needs to maintain actively a wh-filler until it is associated with its gap.

References

Akar, D. (1990). *Wh-questions in Turkish*. M.A. Thesis. Boğaziçi University, İstanbul, Turkey.

Akar, D. (2000). Wh-questions in Turkish. Rona, B. (Ed.), in *Current Issues in Turkish Linguistics volume II* (pp.67 – 74). Ankara: Hitit Publications.

Aoshima, S., Phillips, C., and Weinberg, A. (2004). Processing filler-gap dependencies in a head-final language. *Journal of Memory and Language*, 51, 23 – 54.

Arslan, C. (1999). *Approaches to Wh-Structures in Turkish,* M.A. Thesis. Boğaziçi University, İstanbul, Turkey.

Crocker, M.W. (1999). Mechanisms for sentence processing. S. Garrod and M. Pickering (Eds.), in *Language Processing* (pp.191 – 223). Psychology Press Ltd. Publishers, UK.

De Vincenzi, M. (1991). *Syntactic parsing strategies in Italian*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Fodor, J. D. (1978). Parsing strategies and constraints on transformations. *Linguistic Inquiry*, 9 (3), 427 – 473.

Frazier, L., and Rayner, K. (1982). Making and correcting errors during sentence comprehension: eye movements in the analysis of structurally ambiguous sentences. *Cognitive Psychology*, v.14, 178 – 210.

Frazier, L. (1984). Modularity and the representational hypothesis. *Proceedings of NELS 15* (pp.131 – 144). Brown University, Providence, Rhode Island.

Frazier, L. (1987). Syntactic processing: evidence from Dutch. *Natural Language and Linguistics Theory*, 5, 519 – 560.

Frenck-Mestre, C. (2005). Eye-movement recording as a tool for studying syntactic processing in a second language: a review of methodologies and experimental findings. *Second Language Research*, 21 (2), 175 – 198.

Garrod, S. (2006). Psycholinguistic Research Methods. Keith Brown (Ed.) *Encyclopedia of Language and Linguistics, 2nd Edition* (251 – 257). Elsevier.

Görgülü, E. (2006). Variable wh-words in Turkish. *MA Thesis*, Boğaziçi University, İstanbul, Turkey.

Haegeman, L. (1992). *Introduction to government and binding theory*. Oxford: Blackwell Publishers.

Harley, T. (2005). *The psychology of language*. Hove; New York: Psychology Press.

Hawkins, J. A. (1999). Processing complexity and filler-gap dependencies across grammars. *Language*, 75, (2), 244 – 285.

İşsever, S. (2003). Information structure in Turkish: the word order-prosody interface. *Lingua*, 113, 1025-1053.

İşsever, S. (2009). A syntactic account of wh-in-situ in Turkish. S. Ay, Ö. Aydın, İ. Ergenç, S. Gökmen, S. İşsever, and D. Peçenek (Eds.). in *Essays on Turkish Linguistics: Proceedings of the 14th international conference on Turkish linguistics*. (pp.103 – 112). Wiesbaden: Harrassowitz Verlag.

Just, M. A., and Carpenter, P. A. (1980). A theory of reading from eye movements to comprehension. *Psychological Review*, 87, 329 – 354.

Kaan, E. (1997). *Processing subject-object ambiguities in Dutch*. PhD dissertation, University of Groningen, Netherlands.

Kornfilt, J. (1996). On some infinitival wh-constructions in Turkish. *Dilbilim Araştırmaları*, 192-215.

Kornfilt, J. (2003). Scrambling, subscrambling, and case in Turkish. S. Karimi (Ed.). in *Word Order and Scrambling* (pp.125 – 155). Blackwell Publishing.

Kural, M. (1992). Properties of Scrambling in Turkish. *Ms. Thesis*. UCLA, USA.

Meseguer, E., Carreiras, M., and Clifton, C. Jr. (2002). Overt reanalysis strategies and eye movements during the reading of mild garden path sentences. *Memory and Cognition*, 30 (4), 551 – 561.

Mitchell, D. C., Shen, X., Green, M. J., and Hodgson, T. L. (2008). Accounting for regressive eye-movements in models of sentence processing: A reappraisal of the selective reanalysis hypothesis. *Journal of Memory and Language*. 59, 266 – 293.

Miyamoto, E.T., and Takahashi, S. (2002). The processing of wh-phrases in Japanese, *Scientific Approaches to Language*, 1, 133-172.

Miyamoto, E.T., and Takahashi, S. (2004). Filler-gap dependencies in the processing of scrambling in Japanese. *Language and Linguistics*, 5 (1), 153-166.

Ng, S. (2008). An active gap strategy in the processing of filler-gap dependencies in Chinese. K.M. Chan and H. Kang (Eds.). *Proceedings of the 20th North American Conference on Chinese Linguistics (NACCL-20)* 2, 943 – 957. Columbus, Ohio.

Özsoy, S. (1996). A' dependencies in Turkish. B. Rona (Ed.). *Current Issues in Turkish Linguistics, Proceedings of the 5th International Conference on Turkish Linguistics*,

15 – 17 August, 1990, School of Oriental and African Studies, University of London, 1, (pp.139-158). Hitit Yayınevi, Ankara.

Özsoy, S. (2009). Turkish as a (non)-wh-in-situ language. E. A. Csato, G. Ims, J. Parslow, F. Thiesen, E. Türker (Eds.). In *Turcological Letters to Bernt Brendemoen* (pp.221 – 232). Oslo: Novus Forlag.

Pickering, M.J., and R.P.G. van Gompel (2006). Syntactic Parsing. M. J. Traxler and M. A. Gernsbacher (Eds.). in *Handbook of Psycholinguistics: 2nd Edition*. (pp.455 – 503). Elsevier.

Rado, J. (1999). *Some effects of discourse salience on gap filling*. Poster presented at the 12th Annual CUNY Conference on Human Sentence Processing, 18 – 20 March, 1999, CUNY Graduate Center, New York, NY.

Rayner, K., Carlson, M., and Frazier, L. (1983). The interaction of syntax and semantics during sentence processing: Eye-movements in the analysis of semantically biased sentences. *Journal of Verbal Learning and Verbal Behavior*, 22, 358 – 374.

Rayner, K., and Pollatsek, A. (1989). *The psychology of reading*. Hillsdale, New Jersey: Lawrence Earlbaum Associates.

Rayner, K., and Pollatsek, A. (2006). Eye movement control in reading. M. J. Traxler and M. A. Gernsbacher (Eds.). *Handbook of Psycholinguistics, 2nd Edition* (pp.613 – 657). Elsevier.

Schlesewsky, M., Fanselow, G., Kliegl, R., and Krems, J. (2000). The subject preference in the processing of locally ambiguous wh-questions in German. B. Hemforth, and L. Konieczny (Eds.). In *German Sentence Processing* (pp. 65 – 93). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Sekerina, I. A. (2003). Scrambling and processing: Dependencies, complexity and constraints. S. Karimi (Ed.). In *Word order and scrambling*. (pp.310 – 324). Malden, MA: Blackwell Publishing.

Stowe, L. A. (1986). Parsing wh-constructions: evidence for on-line gap location. *Language and Cognitive Processes*, 1 (3), 227 – 245.

Trueswell, J., Tanenhaus, M., and Kello, C. (1993). Verb-specific constraints in sentence processing: Separating effects of lexical preference from garden-paths. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 19 (3), 528 – 553.

Ueno, M., and Kluender, R. (2003). On the processing of Japanese wh-questions: Relating grammar and brain. G.Garding and M. Tsujimura (Eds.). In *Proceedings of the 22nd West Coast Conference on Formal Linguistics*. (pp.491 – 504). Somerville, MA: Cascadilla Press.

Uzun, N.E. (2000). *Ana çizgileriyle evrensel dilbilgisi ve Türkçe*. İstanbul: Multilingual.

Van Gompel, R. P. G. (2006). Sentence Processing. K. Brown. (Ed.). In *Encyclopedia of Language and Linguistics, 2nd Edition* (pp.251 – 255). Elsevier.