

Quantification Scope Ambiguity Resolution: Evidence from Persian and English

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Abstract

This study investigates the interpretation of scopally ambiguous sentences containing noun phrases with double quantified constituents from a processing perspective. The questions this study tried to answer were: whether or not the preferred interpretation for doubly quantified ambiguous sentences in English was influenced by English learners' L1 scope interpretation possibilities; whether or not the preferred interpretation of ambiguous sentences with double quantificational noun phrases was driven by surface configurations of sentences in English and Persian for SL learners of English either in off-line or on-line reading; and finally, whether or not the referential contexts of ambiguous sentences with double quantificational noun phrases in English and in Persian guided interpretation preferences for SL learners in off-line and on-line readings. Using an off-line judgment task and an on-line truth-value judgment task combined with a self-paced reading technique, the data of the study were collected from the Persian speakers and English learners.

The results obtained from offline tasks indicated that the interpretation preferences of L2 learners of English were influenced by their background language. However, such influences were not found in the self-paced study. Furthermore, it was indicated that the surface configurations of sentences strongly affected L2 learners' interpretation preferences favoring isomorphic interpretation for the universal quantifiers included in the subject position. Concerning the semantically referential-context effect on ambiguity resolution, the collected data revealed that context played a crucial role in the processing of scope ambiguity since the RTs for acontextualized stimuli were more than for contextualized ones in constructions with QNP-QNP in Persian and English.

Keywords: Quantification, Scope Ambiguity, On-line Tasks, Off-line Tasks

1. Introduction

The domain of quantifier scope interpretation is characterized by idiosyncratic variation across different languages. Where one language allows quantified sentences to be interpreted ambiguously, another language exhibits isomorphism in mappings between its syntactic structures and interpretations. This study investigates the nature of quantifier scope relations in English and Persian because they offer a rich opportunity for linguistic investigation as they lie squarely at the interface between form and meaning. There are, still, considerable debates among syntacticians and semanticists as to whether the surface structure of a sentence maps directly and transparently onto a semantic representation, or whether some linguistic level of representation intervenes between the visible surface form and sentence interpretation. A scope-ambiguous sentence, where multiple truth conditions can arise from a single surface form, can serve as a test case for theories of the syntax-semantics interface. Some current theories of quantifier interpretation hold that the locus of quantifier scope ambiguity is at logical form (LF), while in other theories positing no such a level, the ambiguity arises in the derivation of the surface syntax or in the mapping from the syntax to the semantic representation.

Quantifier scope ambiguity is also important for the field of psycholinguistics since it provides an opportunity to study the extent to which linguistic structures and conceptual knowledge contribute to on-line interpretive decisions. Any psycholinguistic insights that we can gain from the interpretation and comprehension of scope-ambiguous sentences among SL learners might help adjudicate between those linguistic theories that posit a covert level of syntactic representation as an interface to the semantics, and those that do not.

2. QNP-QNP Interaction in English and Persian

It is well known that doubly-quantified sentences in English, such as (1), (2), and (3) are ambiguous allowing both subject-wide ($S > O$) and object-wide ($O > S$) scope interpretations.

1) Someone read every book.

$S > O$ interpretation: There was some person x , such that x read every book.

$O > S$ interpretation: For every book y , there was someone who read y .

2) A boy greeted every girl.

$S > O$ interpretation: There was a boy x , such that x greeted every girl.

$O > S$ interpretation: For every girl y , there was a boy who greeted y .

In other words, one interpretation of (2) is that there exists a single boy who greeted all the girls. This interpretation can be logically represented as (2.1):

2.1) $\exists x [\text{boy}(x) \ \& \ \forall y [\text{girl}(y) \rightarrow \text{greeted}(x, y)]]$

The second interpretation of (3), represented in (2.2), corresponds to a scenario in which each girl was greeted by some possibly different boy.

2.2) $\forall x [\text{girl}(x) \rightarrow \exists [\text{boy}(y) \ \& \ \text{greeted}(y, x)]]$

3) Everyone loves someone.

$S > O$ interpretation: There is a person x , such that x is loved by everyone.

$O > S$ interpretation: For someone y , there is a person who loves y .

These two interpretations are due to the fact that a doubly-quantified sentence has two LFs leading to ambiguous sentences (May, 1977, 1985) as their converted forms are represented in (3.1) and (4.2) below:

3.1) LF₁: $[_{IP} \text{everyone}_1 [_{IP} \text{someone}_2 [_{IP} t_1 [_{VP} \text{loves } t_2]]]]$

3.2) LF₂: $[_{IP} \text{someone}_2 [_{IP} \text{everyone}_1 [_{IP} t_1 [_{VP} \text{loves } t_2]]]]$

Persian language also has some similarity to English regarding the interaction of doubly-quantified noun phrases (QNPs); nonetheless, in some sentences it exhibits scope rigidity. Sentences (4), (5), and (6) show the QNP-QNP interaction in Persian.

4) Ye kas-i har kas-i ro
doost dareh.

one person (Indef.) every person (Obj Marker) love-PRES-3SG
Someone loves everyone.

The Persian sentence (4) is ambiguous due to "Ye Kas-i" (someone) as an existential quantifier in the subject position scoping over "har kas-i" (everyone) as a universal quantifier in the object position. The surface interpretation of the sentence is that "there is one person who loves all". In this case "har kas-i" is in the scope domain of "ye kas-i" in the above sentence. The second interpretation of the very sentence is that "each person is loved by a different person" which is its inverse-scope reading.

5) Har kas, kasi-ro pasandid.
Every person, a person -OM admire-PAST-3SG
Everyone admired someone.

Sentence (5) in Persian is ambiguous. Its unmarked interpretation is that all persons in the domain admired one person. In addition to the first unmarked surface-scope interpretation, it can be interpreted as "for every person there was some person to be admired" which is the inverse-scope or non-isomorphic interpretation of the sentence.

6) Yek-i bud ke har kas-i-ro davat mi-kard.
One be-PAST who ever person-OM invite-PAST-DUR-3SG
There was someone who was inviting everyone.

Sentence (6) is also ambiguous because of being interpreted as "there was one who was inviting all" and "for each person, there was some person to be invited".

As alluded above, the first interpretation of each sentence is called the *surface scope interpretation*. The second possible interpretation of each is called the *inverse scope interpretation*.

Many linguists have argued that the resolution of ambiguity of doubly quantified sentences is driven by the learners respective L1s. Due to cross-linguistic variations among languages tackling the phenomena, some

contend that interferences between first language and L2 can play an important role. Where one language allows quantified sentences to be interpreted ambiguously, another language exhibits isomorphism in mappings between the syntactic structure and its interpretation. As Persian and English are typologically different languages, the motivation is to inquire whether Persian background plays any roles in acquisition and interpretation of sentences with double QNPs and negation.

There are others who argue that the ambiguity of doubly quantified sentences arises at the syntactic level of Logical Form (LF). In other words, a single surface syntactic structure of each sentence possesses more than one possible LF structure, and these multiple LFs lead to multiple distinct interpretations of the sentence (May, 1977, 1985). May (ibid.), on that account, argued that the syntactic operation of quantifier raising (QR) takes a quantified determiner phrase (DP) from its uninterpretable object position in the surface structure and moves it covertly to an LF position where it can be interpreted. Hence the source of information influencing ambiguity resolution is driven by syntax. This study attempted to tackle the issue with learners from Persian background to consolidate a reliable ground to base the available linguistic and processing theories. Although many studies have investigated the role of phrase-structure-based parsing strategies (Frazier & Fodor, 1978; Frazier, 1987; Frazier & Rayner, 1982), the issue is still controversial.

Furthermore, multiple-constraints accounts (MacDonald, 1994; Thornton, Gil & MacDonald, 1998; Thornton, MacDonald & Gil, 1999) and the referential context hypothesis (Crain & Steedman, 1985; Altmann & Steedman, 1988; Steedman & Altmann, 1989; Altmann, Garnham & Dennis, 1992) argue that in addition to phrase-structure information, both lexical and discourse information influence the parsing of ambiguous sentences at any given point during sentence comprehension. Even though many studies have investigated the role of contextual information (Crain & Steedman, 1985; Altmann & Steedman, 1988; Steedman & Altmann, 1989; Altmann et al., 1992) in comprehending ambiguous sentences, the question of which sources of information are available to the parser at early stages of processing remains controversial and worthy of investigation (Papadopoulou & Clahsen, 2006).

3. A Brief Account of Studies on Quantified Noun Phrases

3.1 Hierarchical Principles Interact to Determine Scope Preferences

Two early studies that gathered interpretive judgments about scope preferences (Ioup, 1975; VanLehn, 1978) proposed hierarchies that accounted for perceivers’ scope preferences in terms of the intrinsic properties of quantifier-determiners. In both studies, *each* occupied the highest position in the hierarchy, indicating its strong preference to have wide scope over other elements in a sentence. *Every* occupied the next highest position and other quantifiers came lower in the hierarchy. In her study, Ioup (1975) found that on the basis of the following hierarchy, scope preferences are determined:

each > *every* > *all* > *most* > *many* > *several* > *some_{pl}* > *a few* (Ioup, 1975: 73-4)

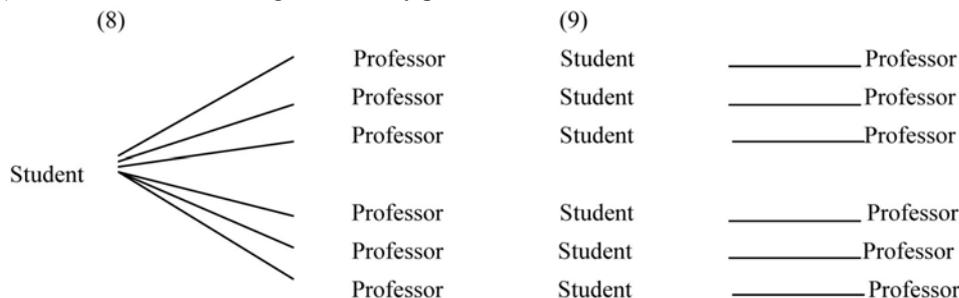
She realized that the larger the set defined by the quantifier, the greater tendency for wide scope. Both studies also acknowledged the influence of the role of the quantified expression in the sentence in influencing scope preferences. Ioup (1975) proposed a Grammatical Hierarchy whereby topics have the greatest preference to take wide scope, followed by subjects and then objects. The following is the hierarchy denoted by her:

Topic > *Deep and surface subject* > *Deep subject or surface subject* > *Prepositional object* > *Indirect object (IO)* > *Direct object (DO)* (Ioup, 1975: 78-81)

3.2 Non-Linguistic Information Determines Scope Preferences

Fodor (1982) argued that scope relations are represented in the mind not in linguistic form, but rather as models of the world that can be schematized with simple diagrams. A sentence like (7), then, has only one syntactic representation, that is, its surface structure, but has two potential conceptual representations corresponding to the two models shown in (8) and (9) below.

(7) A student greeted every professor.



We see that the two distinct conceptual representations do not map directly to the truth conditions of the two interpretations. The model shown in (9) necessarily maps to the inverse-scope interpretation, but the truth conditions of the inverse-scope interpretation are such that there need not be multiple distinct students as long as each professor is greeted by someone, possibly the same student for all the professors. So model (9) could also serve as a conceptual representation for the inverse-scope interpretation of sentence (7). The surface-scope interpretation of (7), on the other hand, where a single student greets all the professors, corresponds only to model (8). For Fodor (1982), the conceptual representation that a perceiver develops for a given sentence is of greater interest than the logical entailments of linguistic semantic representation. In other words, the fact that the surface scope interpretation of (7) entails an interpretation where each professor is greeted is less interesting than the fact that a distinct conceptual representation containing multiple students is possible.

Since interpretation occurs incrementally in Fodor's system, the linear order of quantifiers in the surface syntax plays a role in determining scope preferences. It is therefore relatively easy to interpret *every* with wide scope when it is encountered early in the sentence, since everything that follows *every* can be interpreted in its scope. On the other hand, giving *every* wide scope in an "*a...every*" sentence like (7) should be relatively more difficult and thus dispreferred, since *a student* is initially "assigned a singular representation, which must then be revised when the universal quantifier is encountered" (Fodor, 1982:48). This non-linguistic system of representation thus predicts a preference for the surface-scope interpretation in both the kinds of sentences that the researcher is concerned with, although the surface-scope preference for "*a...every*" sentences should be stronger. In other words, the inverse-scope interpretation should be more strongly disfavored in "*a...every*" sentences than in "*every...a*" sentences. On the other hand, if the discourse context leads the perceiver to construct a mental model that includes multiple students, then presumably there is little reason to initially assign a singular representation for the existential quantifier. It should therefore be easier to assign the inverse-scope interpretation of (7) following a context that supports it, since the mental model of multiple students already exists.

3.3 Multiple Constraints Interact to Determine Scope Preferences

The early psycholinguistic studies of interpretive preferences for scope-ambiguous sentences drew conclusions based on perceivers' introspective grammaticality judgments. In Kurtzman and MacDonald's (1993) study, participants were timed while they read pairs of sentences such as those in (10) and (11) and judged whether the second sentence was an acceptable continuation for the first.

(10) A kid climbed every tree.

The kid was full of energy.

(11) A kid climbed every tree.

The kids were full of energy.

The singular continuation in (10) corresponds to the surface-scope interpretation of the doubly-quantified sentence and the plural continuation in (11) corresponds to the inverse-scope interpretation. The experiment included "*every...a*" sentences as well as "*a...every*" sentences. While this task still relies on conscious judgments of linguistic intuition, the time constraint of the task should allow for a more accurate measure of perceivers' real-time comprehension of quantified sentences than introspective judgments do.

Kurtzman and MacDonald's study tested several of the principles such as the Grammatical Hierarchy and the C-command Hierarchy, as well as other related structural principles, in order to evaluate which principles the parser uses in making interpretive decisions about doubly quantified sentences. While some of their results showed the same preference for surface-scope interpretations observed in previous studies, the overall pattern of data led the authors to argue for an account in which multiple principles interact to influence scope preferences. The two primary principles that Kurtzman and MacDonald identify are the Thematic Hierarchy Principle and the Single Reference Principle. According to the Thematic Hierarchy Principle, agentive phrases have the greatest preference to take wide scope, followed by experiencers and then patients, while the Single Reference Principle captures the intuition of Fodor (1982) that an existential "*a*" will be interpreted as having a single referent if it is encountered before "*every*" in a sentence.

3.4 LF Structure Determines Scope Preferences

The remaining accounts of the real-time comprehension of quantifier scope ambiguity are those that emphasize the role of linguistic structure. At least two theoretical proposals (Pritchett & Whitman, 1995; Reinhart, 1997) predict that surface-scope interpretations are preferred because they have a more economical LF structure, hypothesizing that sentences with more complex LFs consume more processing resources.

In order to be assured about the validity of the aforementioned theories existing in the literature, the following questions were posed to adjudicate the case in point with second language learners of English from Persian background. Do Persian learners of English attach preferentially-divergent interpretations to ambiguous sentences with double quantificational noun phrases due to the scope interpretation possibilities in their L1? Is the interpretation of scope-ambiguous sentences with double quantificational noun phrases driven by the surface structure of sentences in English and Persian for English language learners in either off-line or on-line reading? Do referential and discoursal contexts of scope-ambiguous sentences with double QNPs in English guide the preferred interpretation preferences for SL learners in off-line and on-line readings? Does the same case hold in Persian language too?

4. Methodology

4.1. Participants

Fifty adult native speakers of Persian were selected. Thirty out of fifty subjects were females while the other twenty were males (both genders age range: 23-27). They were English students studying for Masters degrees at the branches of Azad University at Tabriz, Maragheh, and Bonab, who were selected through the administration of the OPT (Oxford Placement Test) from about four hundred students studying in English programs including teaching, translation and literature. The participants were, then, assigned to two experimental groups (each with 25 subjects) through random selection. The subjects of the experimental group A received the experimental stimuli with and without a biasing context by on-line experimentation; whereas, the other twenty five subjects assigned to the experimental group B received the same stimuli through off-line mode.

4.2. Materials

To be able to test the aforementioned hypotheses, 66 experimental stimuli half Persian and other half English were constructed. Then, the whole test was divided into two parts, one part incorporating thirty-three acontextualized stimuli in Persian and English and the other containing the same number of contextualized stimuli in Persian and English. In other words, there were two types of grammatical judgment (GJ) tasks as: 1) the acontextualized English stimuli with double quantifiers – an existential or a universal quantifier in internal and external arguments – which is represented as “AC_ENG_QNP_QNP”, 2) the acontextualized stimuli in Persian with double quantificational noun phrases symbolized as “AC_PER_QNP_QNP”. These two types of acontextualized stimuli were included in the first administration. In addition to these main preference tasks in the first test, there were practice stimuli and fillers as well. The second division also incorporated the aforementioned two main types of GJT stimuli in addition to the practice and fillers except that all of them were preceded by highly biased referential contexts. The abbreviation used for these stimuli were “CC_ENG_QNP_QNP”, and “CC_PER_QNP_QNP”, respectively. The main stimuli in each division were 24 stimuli. That is, twelve stimuli on “AC_ENG_QNP_QNP”, and twelve on “AC_PER_QNP_QNP”. Added to these were seven fillers (unambiguous stimuli) which were randomly inserted within the main stimulus types to minimize guessing towards surface-scope or inverse-scope interpretation. In addition, there were two practice stimuli included at the beginning of each main section to familiarize the participants with the task the data of which had not been considered. The second division contained the same number of stimuli in each section with the only difference that they were preceded by biased referential contexts, giving clues to the acceptability of one interpretation for ambiguous stimuli of each section.

Following each stimulus, there were two possible paraphrases of the semantically-ambiguous sentence due to QNP-QNP with at least two interpretations. On the basis of the truth value conditions of each sentence and stimulus – the truth value judgment tasks (Crain and Thornton, 1998) – the participants chose either the best paraphrase or the best continuation of the sentence presented to them through the choices. To test the probable negative or positive effects from participants' L1, the stimuli were constructed from QNP-QNP which had the same interpretation possibilities in both Persian and English leading to positive transfer; those which had one interpretation in Persian while having two interpretations in English leading to negative transfer; and those stimuli which had two different readings in Persian but one in English were included.

4.3. Experiment 1: OFF-LINE (Note 1) STUDY

The purpose of this experiment was to examine the role of learners' L1 scope preferences of QNP-QNP constructions on their preferred interpretation of English sentences. Through this experiment, two conditions were examined: a neutral condition in which the experimental stimuli were presented in isolation without any preceding biasing context, and a high biasing context preceding the sentence which made stimuli to be favored to either surface or inverse-scope interpretation. With this design, the L1 transfer, multiple-constraint accounts and referential context hypothesis in sentence processing were examined.

4.3.1. The Procedures for the Off-line Tasks

Each division of the designed material was administered once in the off-line experimentation. At first, the acontextualized version, including thirty-three stimuli, was administered to the Group B in the off-line mode. The participants were informed that there was no time limit for their answering; however, it was suggested that they could finish the test in 30 minutes. It should be mentioned that the participants were seated in their own classes because there was no need to other requirements. After the completion of the first phase, a two-week time interval (about 15 days) passed before the second phase of administration. This was needed to lessen the backwash effects from the first testing. After the 15-day interval, the same subjects received the remaining thirty-three contextualized stimuli of the off-line tasks.

4.4. *Experiment 2: ON-LINE (Note 2) STUDY*

The main purpose of this experiment was to investigate how in an on-line experimentation, ambiguous sentences of QNP-QNP type with and without referential context could be disambiguated in English and Persian. The expectation was that the on-line and the off-line tasks would indicate processing accounts from the interpretation preferences of ambiguous sentences.

4.4.1 The Procedures for the On-line Tasks

The participants in Group A were also responded the on-line tasks in two testing sessions at the language laboratories through the computers, one session for answering the acontextualized stimuli and the other for contextualized ones. The two-session testing was because of reducing backwash effects from the former stimuli which were the same in the sentences containing double quantifiers except in that the contextualized version were preceded by biased contexts favoring either toward surface scope or inverse one. After providing the preliminary remarks on the test taking procedures to the participants, they started to practice answering the stimuli which were designed for practicing purposes. The same stimuli of the off-line experiment were designed on the Authorware 7.0 which is a Macromedia program through which response choices, reading times (RT), etc. can be controlled and registered. Hence, this software was installed to the computers at the laboratories. Being familiarized with the running of the program, each participant entered his/her 2 digit identification code (e.g., 01, 02, 10, etc.) at the start of the program and then by pressing space button once, one stimulus appeared on the screen of the computer with its probable answer. After reading the stimulus in the time controlled by participants' first time pressing of the space bar and appearance of the stimulus on the monitor screen until answering to that stimulus through pressing either left or right click of the mouse (the left click representing surface-scope marked as TRUE while the right click representing inverse-scope marked as FALSE) the time was saved and termed as reaction time (RT). The participants could continue to the next stimulus by pressing the space bar again if they were ready, and if they had answered the previous stimulus through clicking of a button of the mouse. This continued up to the end for the first session. The time intervals between the presses of buttons provided the crucial experimental measure. After reading both the no-context and the biased-context stimuli, the participants answered by clicking either of the buttons indicating their preferred interpretation. It should be mentioned that each main stimulus type being 12 appeared 24 times on the monitor screen. The reason for 24-times appearance of the 12 stimuli was that one stimulus appeared once with surface-scope interpretation and the second time with inverse-scope interpretation. Additionally, the time of responding to the contextualized stimuli (RT) was controlled by the participants' pressing of the second-time space bar for having the one option either (surface-scope interpretation), or (inverse-scope interpretation) on the monitor until they click a button on the mouse. The procedure was designed in such a way because of excluding the reading times of the referential contexts preceding the ambiguous sentence appearing by the first pressing of the space bar button. The stimuli through the Authorware 7.0 program were designed in a way that the data regarding the selected choices, RT, code of the subjects, number of stimuli, etc. were saved automatically without any additional action.

5. Results

To find out whether the preferred interpretation of the sentences with double quantifiers which lead to structural ambiguity in English was influenced by learners' L1 scope interpretation possibilities or not, whether the preferred interpretation of such ambiguous sentences is driven by the surface configurations of sentences or not, and whether the referential contexts guide their interpretation preferences or not, the collected data from both off-line and on-line experimentations were analyzed. After the normality and the equality of variances between and among groups were indicated through EDA, the one-way repeated-measures ANOVA was conducted for comparing the means of scores on acontextualized and contextualized stimuli in Persian and English the results of which are given below.

5.1 Influence of L1 Transfer on QNP-QNP Interpretation

For offline experiment, the Mauchly's test indicated that the assumption of sphericity has been met, $\chi^2(5) = 8.253$, $p < .05$, therefore, there was no need for correction estimates. The results showed that the interpretation scores of subjects encountered with ambiguous sentences containing double quantificational noun phrases in English and

Persian in off-line tasks differed significantly, $F(3, 72) = 18.454, p = .000$. The post hoc tests revealed that the means of interpretation scores of the stimulus type 1 were significantly higher than those of the stimulus types 3 and 4 ($p < 0.0125$), also the stimulus type 2's score was also significantly different from the stimulus type 4, however, none of the other stimulus-type scores were significantly different.

Concerning the on-line experiment, the Mauchly's test indicated that the assumption of sphericity has been met, $\chi^2(5) = 6.845, p < 0.05$, therefore, there was no need for correcting degrees of freedom. The results showed that there was no significant difference among the mean scores of the four stimulus types of QNPs interpretation in English and Persian in on-line tasks, $F(3, 72) = 0.813, p = 0.491$. These results suggested that the means in all stimulus types were nearly equal.

5.2 Influence of Surface Configurations of Sentences with QNP-QNP on Interpretation

In off-line experiment, the Mauchly's test indicated that the assumption of sphericity had been violated (Chi-Square = .0, $p < .05$), therefore, the degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity (epsilon = 0.469). The results showed that the score means of the four stimulus types containing double QNPs being ambiguous with different configurations differed significantly, $F(3.280, 78.724) = 17.185, p < .05$. The post hoc tests revealed that the statistical means of the scores from "AC_ENG_QNP_QNP_LF1" and "AC_ENG_QNP_QNP_LF2" were different significantly at $p < .0125$ ($.05/4 = .0125$) weighing positively for the surface scope configuration interpretation preferences (i.e. AC_ENG_QNP_QNP_LF1). The results of the post hoc tests also showed that the means of the scores of "CC_ENG_QNP_QNP_LF1" had not differed significantly from "CC_ENG_QNP_QNP_LF2" substantiating this fact that the inclusion of ambiguous sentences with different QNPs scope configurations did not result in any interpretation preferences. Regarding the third grouping, the means of the scores from "AC_PER_QNP_QNP_LF1" and "AC_PER_QNP_QNP_LF2" were highly significant indicating outperformance towards inverse-scope interpretation preferences namely, AC_PER_QNP_QNP_LF2 with $M = 14.08$ and $SD = 3.390$. The means scores of the last group, "CC_PER_QNP_QNP_LF1" and "CC_PER_QNP_QNP_LF2" were also significantly different at $p < .0125$. The statistical figures demonstrate that the statistical means of "CC_PER_QNP_QNP_LF2" ($M = 16.16$) are rather higher than its counterpart indicating inverse-scope preferences for the contextualized double QNPs stimuli.

In on-line experiment, the Mauchly's test also indicated that the assumption of sphericity had been violated (Chi-Square = .0, $p < .05$), therefore, the degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity (epsilon = 0.412). The results showed that the means of the scores related to the four stimulus types containing QNPs in different scope configurations of ambiguous sentences in English and Persian were not different significantly, $F(2.887, 69.295) = 1.079, p < .05$. Hence, the post hoc tests were not needed.

5.3 Influence of Referential Contexts on QNP-QNP Interpretation

For English sentences, the results revealed that there is a significant difference in the means of the scores for "Off-line_AC_ENG_QNP_QNP_LF1" ($M = 14.16, SD = 3.602$) and "Off-line_CC_ENG_QNP_QNP_LF1" ($M = 11.92, SD = 2.798$) conditions; $t(24) = 2.850, p = 0.009$. These results suggest that the null hypothesis of "referential contexts of ambiguous sentences with double quantificational noun phrases in English do not guide interpretation preferences for SL learners in off-line reading" is rejected. The results of on-line tasks for English stimuli elucidate that there is no significant difference in the means of the scores for "On-line_AC_ENG_QNP_QNP_LF1" ($M = 12.48, SD = 2.124$) and "On-line_CC_ENG_QNP_QNP_LF1" ($M = 12.08, SD = 1.152$) conditions; $t(24) = .866, p = .395$.

For Persian stimuli in off-line experiment, a paired-samples t-test was conducted to compare the interpretation scores of the sentences with double QNPs in both contextualized and acontextualized stimuli through off-line tasks. The outputs of SPSS revealed that there is a significant difference in the scores for "Off-line_AC_PER_QNP_QNP_LF1" ($M = 9.92, SD = 3.390$) and "Off-line_CC_PER_QNP_QNP_LF1" ($M = 7.84, SD = 2.444$) conditions; $t(24) = 2.764, p = 0.011$. These results suggest that the null hypothesis of "referential contexts of ambiguous sentences with double quantificational noun phrases in Persian do not guide interpretation preferences for SL learners in off-line reading" is rejected. Additionally, the amount of $t_{obs} = 2.764$ in comparison with $t_{crit} = 2.064$ at $p < .05$ also confirms the refutation of the null hypothesis.

Concerning to the Persian on-line data, the analyses illustrate that there is no significant difference in the means of the scores for "On-line_AC_PER_QNP_QNP_LF1" ($M = 7.84, SD = 1.528$) and "On-line_CC_PER_QNP_QNP_LF1" ($M = 11.88, SD = 1.166$) conditions; $t(24) = 1.388, p = .178$. These results suggest that the null hypothesis "referential contexts of ambiguous sentences with double quantificational noun phrases in Persian do not guide interpretation preferences for SL learners in on-line reading" is accepted.

6. Discussion

6.1. Influence of L1 Transfer on QNP-QNP Interpretation

The findings in relation to the influence of English learners' L1 scope interpretation possibilities – the Persian language – on the interpretation of structurally ambiguous sentences containing double quantifiers in the subject and object positions substantiated that there is, indeed, such an influence. The comparison of the scores' means of the four stimulus types with QNP-QNP in English and Persian in the off-line tasks highlighted such a positive transfer from L1. The results of one-way repeated-measures ANOVA and the Bonferroni tests indicated that the existence of double quantificational noun phrases in Persian declarative sentences with and without biased contexts affected positively the interpretation of such constructions in English. In other words, the mean scores of "Offline_AC_PER_QNP_QNP" on "Offline_AC_ENG_QNP_QNP", of "Offline_CC_PER_QNP_QNP" on "Offline_AC_ENG_QNP_QNP", and of "Offline_CC_PER_QNP_QNP" on "Offline_CC_ENG_QNP_QNP" objectify such effects.

The theoretical explanation of this hypothesis was Schwartz & Sprouse's (1994, 1996) Full Transfer/Full Access model. According to Full Transfer/Full Access, the initial state of L2 acquisition is the L1 grammar. Subsequent L2 development occurs when the L1-based interlanguage grammar is restructured in order to represent the target language input (Adamson, 2009). This restructuring is constrained by UG.

Assuming Full Transfer/Full Access (Schwartz and Sprouse, 1996), the L2 acquisition of constructions with double QNPs leading to ambiguous interpretations can be eased due to the learners' background language. For Persian-speaking learners of English, no problem was predicted in interpreting universal and existential quantifiers (*every*, *some*, *a* respectively) taking wide or narrow scope. It seems that their interlanguage grammar was target-like from the outset with respect to quantifier scope interpretation, since the Persian grammar behaves like English grammar leading to positive transfer indicated through the results. As Persian allows for the subject and object wide scope taking in sentences with universal and existential quantifiers, even though object-wide scope with cost, this paves acquisition way for its English learners. In a way, whatever UG mechanisms guide the construction of the L1 grammar with respect to scope interpretation are also available in L2 acquisition. Given the right trigger from the target language input, the L1 Persian/L2 English interlanguage grammar could be restructured so that where it is needed to assign wide and/or narrow scope.

Furthermore, one of the truisms of exact comprehension of L2 constructions is that the frequency of elements in the input plays a big role. An obvious example is that words and clusters that are encountered more often are both comprehended more rapidly and uttered more quickly by language users. Therefore, frequency exerts a major influence in interpretation of ambiguities – not only at the lexical level but also at the syntactic level – in which more common interpretations of syntactic ambiguities are preferred to rarer ones, at least in the absence of context (Anderson, 2004; MacDonald, 1994). The constraint-satisfaction (or constraint-based) approach to sentence processing (MacDonald, Pearlmuter, and Seidenberg, 1994; Tanenhaus and Trueswell, 1995; Trueswell, Tanenhaus, and Garnsey, 1994) has provided abundant evidence for the claim that the interaction of multiple probabilistic constraints, ultimately stemming from past experience, determines the semantic and syntactic analyses that are entertained as the sentence unfolds. This assertion has been substantiated for Persian and English ambiguous sentences according to the findings of the study in the off-line tasks; whereas studies conducted in the history, some of which were reported in the Literature Review, show contradictory results. However, in on-line (self-paced) tasks such cases were validated like Korean and other languages.

6.2. Influence of Surface Configurations of Sentences with QNP-QNP on Interpretation

The analyzed data concerning whether the preferential interpretation of ambiguous sentences with double quantificational noun phrases is driven by surface configurations of sentences in English and Persian in off-line tasks confirmed that it influences learners' interpretation. In a stimulus such as "*A member of the club tested every recipe*" in which an existential indefinite quantifier *A* being at external argument position and a universal quantifier *every* landing at internal argument position, L2 learners assigned 59% wide scope for existential quantifier ($a > every$) and 41% for the wide scope of universal quantifier ($every > a$). This is also true for *some* when it is located at the subject position. Even though the percentages in off-line and on-line tasks varied to some extent, they always favored towards wide scope of QNPs located at subject position. The findings of this study also confirm the others in that L2 learners with Persian background prefer wide scope for the constituent which is high enough in its position to c-command the other constituents with any covert movement at LF. Although the activation of other alternatives during processing and comprehension on the basis of the unfolding evidence is without doubt, however, the frequency of the alternatives modulates the relative activation strengths of the alternatives. Finally, one interpretation gains sufficient activation to be adopted, and so the ambiguity resolution process can be seen as one in which distributional patterns of words, phrase types, word

co-occurrences, word-situation co-occurrences, and many others, contribute to the relative weight of alternatives during comprehension (O'Grady, 2008).

The explanation for the above behavior of scope assignment relates to the unmarked nature of surface-scope interpretation and marked one of inverse-scope interpretation making it difficult to be activated. It is frequently observed that inverse-scope readings for sentences, in which an existential quantifier precedes a wide-scope universal quantifier, are relatively difficult to construct (Reinhart, 1997). They are less common typologically than their forward counterparts (Hawkins, 2004), and are less accessible to even native speakers of languages that allow them (Anderson, 2004; Marsden, 2004). As Reinhart (*ibid.*) observes, "[inverse] scope is a marked option: It is often very hard to obtain and it requires a strong discourse motivation" (p. 370).

Reading times were then analyzed according to the subjects' answers to the comprehension question. The sentence was read significantly more slowly when subjects assigned it a multiple-referent interpretation than when they computed the single-referent reading.

In sum, like surface-scope, inverse-scope is the result of a pragmatically-driven operation of multiplication that applies in a serial iterative manner. In addition, the marked character of inverse-scope reflects the extra processing cost associated with the re-computation of the reference of a previously interpreted NP.

6.3. Influence of Referential Contexts on QNP-QNP Interpretation

To test the role of referential contexts in interpretation of structurally ambiguous declarative English sentences with double quantificational elements in both off-line and on-line tasks, the designed stimuli were administered and analyzed the findings of which shed shining lights on the existing proposals and pave the way for new stipulations. The analysis of the results attained from off-line tasks indicated that there was a significant difference in the scores' means of the participants who answered stimuli of the type QNP-QNP with and without biased contexts. This was revealed through the application of t-test statistics for comparing the means of the above two groups of stimuli being as $t_{obs}(24) = 2.850$, $p = 0.009$ which is more than $t_{crit}(24) = 2.064$, $p < .05$. It was found out that in off-line tasks subjects chose 59% answers favoring surface-scope interpretation in acontextualized conditions; whereas that percent was 49.67 for contextualized conditions favoring surface-scope interpretation.

In order to compute an interpretation resulting from a particular scope configuration, it is necessary that the parser build the corresponding LF representation. This implies that, when the quantificational elements are not in the appropriate configuration at surface structure, the parser has to build the structural representation that can feed semantic interpretation. The LF representation is computed along with the syntactic surface structure as the incoming words are perceived on-line.

In the literature review section, it has been argued that scope ambiguity resolution, in the studies conducted, requires a model of parallel evaluation. Kurtzman & MacDonald (1993) proposed a model for the resolution of scope ambiguity in declarative sentences, where the different possible interpretations are initially considered in parallel. A set of scope principles then determines which representation (corresponding to the preferred interpretation) is ultimately selected. Crain & Steedman (1985) and Altmann & Steedman (1988), similarly, proposed that the resolution of structural ambiguity in a context interactive model requires parallel evaluation of partial interpretations. They argued that the appropriate interpretation of an ambiguous sentence in a particular context can only be chosen through comparison of alternatives. In their view, a single interpretation cannot be rejected on grounds of implausibility, but only in comparison with some more plausible alternative. They, therefore, claimed "that weakly interactive processors must by definition propose syntactic alternatives for semantic and pragmatic adjudication *in parallel*." (Altmann & Steedman, 1988: 208).

The main concern of these models was the mechanism that chose among the possible interpretations of a sentence. How the actual disambiguated representations were constructed is, however, not made explicit. The model that was proposed here focuses on the mechanism that actually constructs the disambiguated representations. Once such a mechanism was made explicit, it has been shown that, in the case of ambiguity resolution in constructions with QNP-QNP, parallel evaluation of several partial interpretations becomes unnecessary.

This assertion becomes more valid when we consider the unambiguous baseline condition that shows that inverse-scope interpretation incurs a cost even when it is the only possible interpretation. As Figure 1 shows, the quantified sentence was read just as slowly when it was unambiguous inverse-scope as when it was ambiguous in an inverse-scope context. This fact is compelling evidence against Kurtzman and MacDonald's (1993) parallel processing model. In their model, processing difficulty arises when the two representations are equally weighted, thanks to the input of the various competing constraints that govern interpretive processes. Because both

representations are equally activated, the processor has difficulty committing to one of them. In the unambiguous inverse-scope condition, no other interpretation was possible for the quantified sentence. There should be no competition between representations, and thus no reason to predict processing difficulty. But, in fact, perceivers did experience significant processing difficulty at the unambiguous inverse-scope quantified sentence, difficulty which could not have arisen from competition with an alternative representation.

In addition to the difficulty incurred for inverse-scope interpretation, a vast body of literature has argued for a parser that obeys economy principles when constructing surface representations (cf. the Minimal Attachment Principle, Frazier 1978, Simplicity, Gorrell, 1995, the Minimal Chain Principle, de Vincenzi, 1991, and many others). In this work, I adopt the hypothesis that the construction of LF representations is also governed by economy principles. Indeed, the few recent studies that have been explicit about how corresponding LF representations are associated to surface representations, argue that the parser first chooses to construct the LF that requires minimal changes from the surface representation (e.g. the Principle of Scope Interpretation by Tunstall, 1997 and the Minimal Lowering Principle by Frazier, 1999). Of particular interest is the proposal made by Tunstall (1997), which explicitly addresses the question of how LF representations for sentences with multiple quantifiers are constructed. Her Principle of Scope Interpretation states that the preferred interpretation of a sentence corresponds to the LF that differs minimally from the surface structure.

In a similar vein, I examine the hypothesis that the parser first chooses to construct the LF that has minimal cost. This notion can, of course, be defined in many different ways. Here, I investigate the case in which minimal cost mirrors Tunstall's concept of minimal changes from the surface representation. To make such a proposal explicit, I define the following cost function: the cost of an LF corresponds to the number of permutations that are necessary to derive the order of the quantifiers from their surface order. Thus, an LF in which the quantifiers have been permuted with respect to surface order has higher cost than an LF where the order of such elements is preserved (e.g. $\text{cost}(Q_1Q_2) = 0 < \text{cost}(Q_2Q_1) = 1$). In LF_2 , the quantifiers are reversed with respect to their surface order; in LF_1 , their orders are preserved. For clarification purposes, I have based the discussion on the Minimal Cost Hypothesis (Villalta, 2003) as stated:

Minimal Cost Hypothesis:

When processing a construction with QN_QNP, the parser first computes LF_1 , because it has less cost than LF_2 [$\text{cost}(LF_1) < \text{cost}(LF_2)$]. (Villalta, 2003: 124)

The results of the off-line tasks indicated that participants preferred to choose an LF_1 answer over an LF_2 answer when asked to respond to an ambiguous English stimuli incorporating QNP-QNP. On the basis of the results obtained and analyzed, it has been concluded that the Minimal Cost Hypothesis does make the correct predictions. Perceivers seem to prefer to interpret QNP-QNP constructions with an LF_1 interpretation in acontextualized condition. These results thus suggest that the parsing mechanism can be guided by the kind of Economy considerations expressed in the Minimal Cost Hypothesis. At least, these considerations are sufficient to determine which LF is to be associated with a sentence. However, the results obtained from on-line tasks indicated that there was not such a difference in preferring LF_1 over LF_2 in both acontextualized and contextualized conditions.

Concerning to contextualized conditions of off-line tasks, it was found that an appropriately-biased context plays a significant role in ambiguity resolution in English, in that there were more LF_2 responses when the sentences were preceded by a high-biasing context than when they were presented in isolation, and there were more LF_1 responses in the no-context condition as the Table 1 illustrates. Therefore, the designed materials revealed a significant interaction between contexts and stimuli, indicating that the contexts created were strong enough to influence the interpretation of stimuli with double quantifiers.

The statistical analysis concerning the reading times for acontextualized English stimuli incorporating double QNPs indicated that there was a significant difference in mean Reading Times between LF_1 ($M=8873.703$, $SD=5945.782$) and LF_2 ($M=16024.73$, $SD=29839.4$) conditions; $t(299) = -4.127$, $p = .000$. These results convince us to conclude that LF_2 processing takes more time than LF_1 .

With regard to the reading times of contextualized English stimuli containing double QNPs, it should be asserted that the analysis of t-test once again confirmed that there was such a significance between mean Reading Times of LF_1 ($M=4905.88$, $SD=7827.82$) and LF_2 ($M=10610.52$, $SD=11735.73$) conditions; $t(299) = -7.189$, $p = .000$.

A quick glance at the results of off-line and on-line tasks and specifically at Reading Times (Figure 2) illuminates that processing LF_2 representation was rather non-economical and costly even with the existence of biased contexts favoring such a meaning alongside it.

The results of this experiment are compatible not only with multiple constraints-accounts but also with syntax-first approaches, because even the latter allow for context effects in off-line tasks, as these may reflect final (rather than early) parsing processes. Additionally, all of the scope principles used in the linguistic and psycholinguistic literature predict the preference for an LF₁ answer to constructions with QNP-QNP. That is, the influence of two factors on scope preferences in declarative sentences was predicted. One was the linear left-to-right hierarchy or the structural high-to-low ordering – the *linear order principle* (Fodor, 1982), and the *c-command principle* (Reinhart, 1983). The other factor was the ordering in terms of thematic hierarchy or the preference to give external arguments higher scope – the surface *subject principle* (Ioup, 1975), and the *thematic hierarchy principle* (Grimshaw, 1990; Jackendoff, 1972).

The analysis of the data gathered to test the effect of referential contexts of ambiguous sentences with double quantificational noun phrases in Persian on interpretation preferences of SL learners revealed that there was a significant difference in the score means of acontextualized stimuli and highly-biased contextualized stimuli in interpretation preferences in off-line tasks, but not in on-line one. Statistically speaking, the results of the t-test showed that the difference in means of the scores for Offline_AC_PER_QNP_QNP_LF1” (M=9.92, SD=3.390) and “Offline_CC_PER_QNP_QNP_LF1” (M=7.84, SD=2.444) conditions is significant; $t_{obs}(24) = 2.764$, $p = 0.011$ which is more than $t_{crit} = 2.064$, $p < .05$. It was realized that in off-line tasks subjects chose 41.34% answers favoring LF₁ (surface scope) interpretation in acontextualized conditions; whereas that percent was 32.66 for contextualized conditions favoring LF₁ interpretation.

The above statistics again substantiate the role of biased discursual contexts in ambiguity resolution even for the learners’ native language. Having found out the existence of such a connection, I proceeded with the next step which was to realize whether there was a difference in Reading Times between no-context and biased-context stimuli incorporating QNP-QNP in Persian. Figure 3 and results of t-test following that highlight the points in question obtained from on-line tasks.

The outputs of t-test which compared the means differences in Reading Times for acontextualized LF₁ and LF₂ in self-paced study indicated that there was no significant difference between mean Reading Time scores of acontextualized LF₁ (M=6787.17, SD= 8238.69) and acontextualized LF₂ (M=7282.81, SD=7778.01) conditions; ; $t_{obs}(299) = -0.958$, $p = 0.339$. For contextualized conditions, the results of t-test also revealed that there was no significant difference in means of RTs of LF₁ (M=3719.84, SD=5656.55) and LF₂ (M=3910.29, SD=5296.28) conditions; $t_{obs}(299) = -0.426$, $p = 0.670$. These statistics though do not prove significant differences between LF₁ and LF₂ representations; however, we can notice such slight differences among RTs in even L2 learners’ native language.

7. Concluding Remarks

In recent years, many developmental studies have focused on young children’s scope interpretation of sentences involving a universal and an existential quantificational noun phrases giving rise to ambiguous interpretations. This study has extended the topic to the area of adult L2 learners’ sentence processing, and attempted to document empirical data from a processing perspective. In particular, the researcher investigated QNP-QNP interpretations which can be accessed in comprehension in off-line and on-line tasks and *how* or *when* the relevant scope interpretation is resolved in real time. To explore these questions, a set of off-line and on-line tasks were administered that probed the processing of scope at issue with Persian-speaking learners of English. The core findings of the study were discussed on the basis of the multiple-constraints accounts (MacDonald 1994; Thornton, Gil & MacDonald, 1998; Thornton, MacDonald & Gil, 1999) and the referential context hypothesis (Crain & Steedman, 1985; Altmann & Steedman, 1988; Steedman & Altmann, 1989; Altmann, Garnham & Dennis, 1992), who argued that in addition to phrase-structure information, both lexical and discourse information influence the processing of ambiguous sentences at any given point during sentence comprehension. However, there are many puzzles left unaddressed.

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Notes

Note 1. It was the condition of test administration in which the participants of the first experimental group received the questions and stimuli of the first experiment with classical test-taking procedures, namely that of paper-based exam. Here the stimuli with and/or without referential contexts were presented to them at once and consequently the time spent on the reading of each meaningful section was not significant.

Note 2. It was a testing administration condition in which the participants of the second experimental group received the stimuli through computers in a non-cumulative way being triggered by their pressing a pacing button. The times between button presses were recorded and the whole stimuli were not at their presence at the same time making a contextualization of the stimuli possible.

Table 1. English Interpretation Answers for Ambiguous Sentences with QNP-QNP

Conditions	LF ₁ Answer	LF ₂ Answer	Correct Answers LF ₁	Correct Answers F ₂
Offline_AC_ENG_QNP_QNP	354	246	600	600
Offline_CC_ENG_QNP_QNP	298	302	200	400

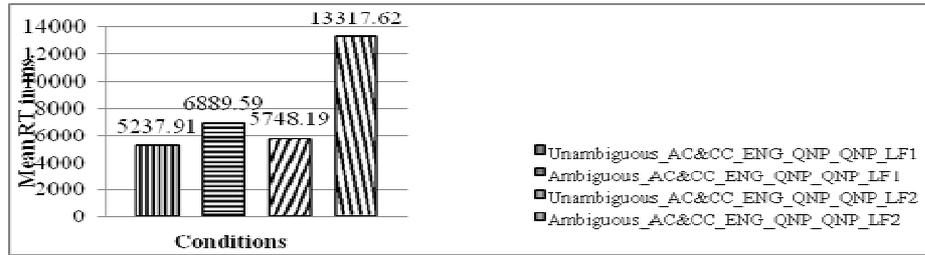


Figure 1. Mean Reading Times for Ambiguous and Unambiguous QNP-QNP in ms.

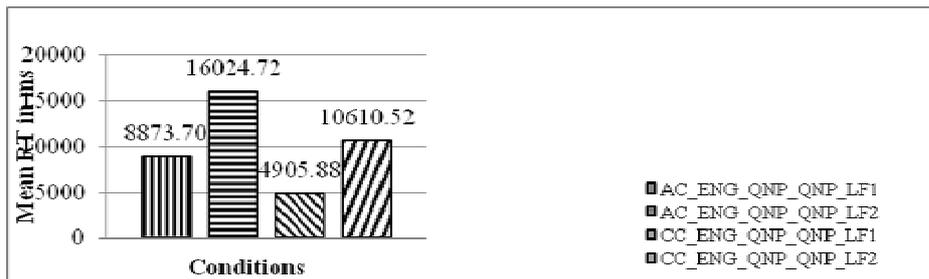


Figure 2. Mean Reading Times for ENG-QNP-QNP in ms.

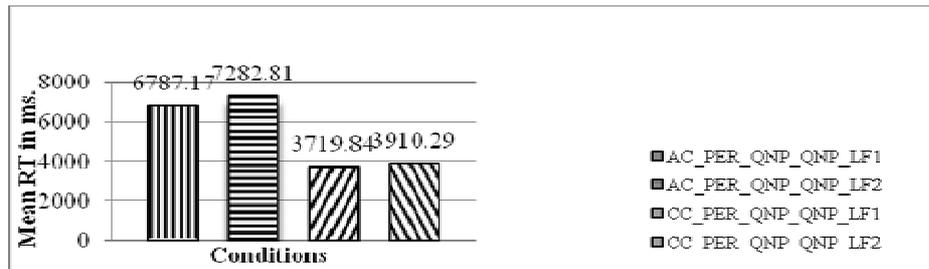


Figure 3. Mean Reading Times for PER-QNP-QNP in ms.