

Quantification and Negation Scope Ambiguity Resolution: An Interlanguage Study

Hassan Asadollahfam (Corresponding Author)

Department of Post Graduate Studies, English Language Teaching Group

Islamic Azad University of Khorasgan

PO box 81595-158, Khorasgan, Isfahan, Iran

Tel: 98-91-4176-3275 E-mail: Asadollahfam@yahoo.com

Ahmad Reza Lotfi

Department of Post Graduate Studies, English Language Teaching Group

Islamic Azad University of Khorasgan

PO box 81595-158, Khorasgan, Isfahan, Iran

Tel: 98-91-3317-8603 E-mail: arlotfi@yahoo.com

Abstract

Two off-line and on-line reading tasks investigated the real-time comprehension of doubly quantified sentences with sentential negation interaction. The results showed that perceivers experienced processing difficulty in assigning inverse-scope interpretations to the sentences with double operators, not only when such sentences appeared in isolation, but also when the preceding context supported the inverse-scope interpretation and when the quantified sentences with negative operators was unambiguously inverse scope. We conclude that the cost of assigning inverse scope arises from the greater syntactic complexity of the inverse-scope representation, as a structure-driven model of the human sentence processing mechanism and referential context hypothesis would predict.

Keywords: Quantifiers, Sentential Negation, Surface Scope, Inverse Scope, Offline and Online Readings

1. Introduction

A sentence that contains a quantified expression and a sentential negation is ambiguous. This paper describes a set of psycholinguistic tasks investigating the real-time comprehension of sentences with quantifiers and negative operators leading to more than one interpretation as (1).

1) Every student didn't answer the question.

The linguistic account of the ambiguity of such sentences postulates that the two possible interpretations arise from the two possible configurations of the quantified expression and negation (*every student* and *not* in (1)) at LF, the level of the syntax that is interpreted by the semantics.

May (May 1977; 1985) proposed that a quantified expression that cannot be interpreted in object position for reasons of semantic type composition (Montague, 1974) undergoes Quantifier Raising (QR), a syntactic operation that moves the quantified phrase covertly to an LF position where it can be interpreted. The QR account provides a natural explanation for the ambiguity of sentences with quantifiers and negative operators. That is, the two interpretations result from the two possible LF landing sites of the quantifier and negative operators. In the example derivations that follow, we use Heim & Kratzer's (1998) modernized version of May's theory, which takes advantage of the VP-internal subject hypothesis (Kitagawa 1986; Kuroda 1988; Koopman and Sportiche 1991), whereby a verb's subject argument originates inside the VP and moves to a position higher in the tree for feature-checking purposes (Chomsky, 2000, 2001; Lotfi, 2006). The logical representations of the above sentence are given in (2). The representation (2a) indicates that the universal quantifier takes (*every*) wide scope over the negative operator (*not*) and in (2b), the reverse is the case.

2)

a. LF₁: $\lambda x[\text{student}(x) \rightarrow \neg \text{answer}(x, \text{the question})]$ (= none of the students answered)

b. LF₂: $\lambda x[\text{student}(x) \rightarrow \text{answer}(x, \text{the question})]$ (= not all the students answered)

On this account, *not* is interpreted inside the scope of the DP *every student*, giving rise to the interpretation where *none of the students answered the question* can be meant. This is known as the *surface-scope*

interpretation, since the quantifier has the same configuration at LF as they do in the surface syntax. On the other hand, if an additional operator-raising move raises the NEG *not* to a position higher than *every student*, as shown in (2b), *not* is interpreted with wider scope than *every student*, which leads to the *inverse-scope interpretation* where *not all the students answered the question* can be the plausible interpretation.

A model of sentence processing in which the parser has an inherent preference for simpler structural configurations (e.g., Frazier and Fodor 1978; Frazier 1987, 1990; Frazier and Clifton 1996) would predict that assigning the inverse-scope interpretation to a quantified sentence with negation would be more difficult than assigning the surface-scope interpretation, because of the greater structural complexity of the inverse-scope configuration. On the other hand, a constraint-based model of sentence comprehension (e.g., MacDonald 1994; Trueswell and Tanenhaus 1994; Trueswell 1996; Spivey and Tanenhaus 1998; Tanenhaus, Spivey-Knowlton and Hanna 2000) would attribute processing difficulty to competition between two representations that the parser considers in parallel. In one such model (Crain and Steedman 1985; Altmann and Steedman 1988), competing analyses are evaluated in parallel for plausibility with respect to the discourse context. Since the parser prefers the analysis that "carries fewer unsupported presuppositions" (Altmann & Steedman 1988: 203), accommodating additional presuppositions (such as the existence of some students) leads to processing difficulty.

The results of the truth value judgment tasks (TVJT) presented here show that perceivers experience processing difficulty when they assign inverse scope to a sentence containing a quantificational element and sentential negation, not only when the sentence is in isolation, but also when the discourse context supports the inverse-scope interpretation and when the sentence is unambiguous inverse scope. The results indicate that this processing difficulty is not attributable merely to competition between alternative parses or to referential complexity, but to the structural complexity of the inverse-scope configuration. We conclude that computing quantifier scope relations in real time crucially involves syntactic processing, not just general conceptual inferencing.

2. Methodology

2.1. 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.

2.2. 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 a quantifier and sentential negation – an existential or a universal quantifier – which is represented as "AC_ENG_QNP_NEG", 2) the acontextualized stimuli in Persian with a quantificational noun phrase interacting with sentential negation symbolized as "AC_PER_QNP_NEG". 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_NEG", and "CC_PER_QNP_NEG", respectively. The main stimuli in each division were 24 stimuli. That is, twelve stimuli on "AC_ENG_QNP_NEG", and twelve on "AC_PER_QNP_NEG". 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-NEG 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-NEG 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.

2.3. *Experiment 1: OFF-LINE (Note 1) STUDY*

The purpose of this experiment was to examine the role of learners' L1 scope preferences of QNP-NEG 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.

2.3.1. 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.

2.4. *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-NEG 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.

2.4.1. 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 quantifiers and sentential negation 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.

3. Results

To find out whether the preferred interpretation of the sentences with quantifiers and sentential negation leading 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.

3.1. Influence of L1 Transfer on QNP-NEG Interpretation

In off-line experiment, the Mauchly's test indicated that the assumption of sphericity has been met, $\chi^2(5) = 10.717$, $p < 0.05$, therefore, there was no need for correcting degrees of freedom. The results showed that there was a significant difference among the score means of the four stimulus types of QNP-NEG interpretation in English and Persian in the off-line tasks, $F(3, 72) = 5.882$, $p = 0.001$. These results suggested that some stimulus types were higher in means than others. Given the main effect among different types of QNP-NEG stimuli in English and Persian was significant, the Bonferroni correction post hoc tests were performed which had four levels of comparisons and accordingly, its probability value was as $.05/4 = .0125$. The results indicated that there was no significant difference in the means of the scores related to the four stimulus types of QNP-NEG in English and Persian at $p < .0125$ in the off-line tasks, although at $p < .05$ its significance was evident.

In on-line experiment, the Mauchly's test indicated that the assumption of sphericity has been met, $\chi^2(5) = 10.325$, $p < 0.05$, therefore, there was no need for the degrees of freedom to be corrected. The results showed that there was no significant difference among the means of the four stimulus types of QNP-NEG interpretation in English and Persian in on-line tasks, $F(3, 72) = 2.264$, $p = 0.088$. These results suggested that none of the stimulus types was significantly different than others in terms of mean.

3.2. Influence of Surface Configurations of Sentences with QNP-NEG on Interpretation

Concerning the off-line experiment, the Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(27) = .000$, $p < .05$, therefore, the degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\epsilon = 0.420$). The results showed that the means of the four stimulus types containing QNP-NEG being ambiguous with different configurations differed significantly, $F(2.942, 70.608) = 15.765$, $p < .05$. The post hoc tests revealed that the statistical means of the scores from "AC_ENG_QNP_NEG_LF1" and "AC_ENG_QNP_NEG_LF2" are different significantly at $p < .0125$ ($.05/4 = .0125$) with an outperformance towards the inverse-scope configuration interpretation preferences (i.e. AC_ENG_QNP_NEG_LF2). The results of the post hoc tests of the next pair namely those of 3 and 4 showed that the means of the scores in "CC_ENG_QNP_NEG_LF1" had not differed significantly from "CC_ENG_QNP_NEG_LF2" substantiating the fact that the inclusion of the ambiguous sentences with QNP-NEG configurations did not result in any interpretation preferences in English and Persian. Concerning the third grouping, the means of the scores from "AC_PER_QNP_NEG_LF1" and "AC_PER_QNP_NEG_LF2" were highly significant indicating the outperformance towards the inverse-scope interpretation preferences namely, AC_PER_QNP_NEG_LF2 with $M = 15.84$ and $SD = 3.693$. The means of the scores for the last group, "CC_PER_QNP_NEG_LF1" and "CC_PER_QNP_NEG_LF2" were not significantly different at $p < .0125$, implying that the sentences with QNP-NEG scope configurations in Persian did not affect interpretation preferences of second language learners of English.

In on-line mode, 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 = 0.371). The results showed that the means of the scores related to the four stimulus types containing QNP-NEG in different scope configurations of ambiguous sentences in English and Persian were not different significantly, $F(2.594, 62.260) = 1.616$, $p < .05$. Hence, the post hoc tests were not needed.

3.3 Influence of Referential Contexts on QNP-NEG Interpretation

The paired t-test statistics for the off-line experiment for English sentences illustrate that there is a significant difference in the score means of "Off-line_AC_ENG_QNP_NEG_LF1" ($M = 8.32$, $SD = 3.859$) and "Off-line_CC_ENG_QNP_NEG_LF1" ($M = 11.12$, $SD = 3.789$) conditions; $t(24) = -2.711$, $p = .012$. Regarding

the on-line mode, a paired-samples t-test was conducted to compare the interpretation scores of the sentences with QNP-NEG interaction in both acontextualized and contextualized conditions. The outputs of the analyses reveal that there is no significant difference in the scores means of “On-line_AC_ENG_QNP_NEG_LF1” (M=12.68, SD=1.887) and “On-line_CC_ENG_QNP_NEG_LF1” (M=12.24, SD=1.422) conditions; $t(24) = 1.269$, $p = .217$.

Concerning Persian sentences, a paired-samples t-test was conducted to compare the interpretation scores of the Persian sentences with QNP-NEG interaction administered for L2 learners of English in off-line experimental condition. The results reveal that there is a significant difference in the means of the scores for “Off-line_AC_PER_QNP_NEG_LF1” (M=8.16, SD=3.693) and “Off-line_CC_PER_QNP_NEG_LF1” (M=10.24, SD=2.847) conditions; $t(24) = -2.561$, $p = 0.017$. However, the analyses of the on-line data reveal that there is no significant difference in the scores means of “On-line_AC_PER_QNP_NEG_LF1” (M=11.48, SD=2.519) and “On-line_CC_PER_QNP_NEG_LF1” (M=12.20, SD=0.957) conditions; $t(24) = -1.325$, $p = 0.197$.

4. Discussion

4.1. Influence of L1 Transfer on QNP-NEG Interpretation

The findings concerning the influence of L1 scope preference of QNP-NEG on learners L2 interlanguage grammar in off-line tasks indicated that in acontextualized stimuli they have chosen 52.84% surface scope interpretation of the sentences in English, whereas, their preference regarding the Persian Stimuli in inverse-scope interpretation was 52.16%. This scope, assigning possibilities with contextualized stimuli of the type QNP-NEG, have not differed significantly in off-line tasks (English surface-scope percentages 51%, Persian surface-scope percentages 50.84%). A short glance at these percentages explicates this point that there should not be such a big and effective influence from either of the learners' background language influence to the other. However, these percentages differed a little in off-line tasks indicating again no drastic influence from learners' L1 towards L2 or vice versa [(AC_ENG_QNP_NEG_LF1 as 34.66% while it was 34% for AC_PER_QNP_NEG_LF1) (CC_ENG_QNP_NEG_LF1 = 46.34%, whereas being 42.66% for CC_PER_QNP_NEG_LF1)]. All in all, these percentages and the analyses regarding the influence of L1 scope preferences indicated that there was no such a significant influence from learners' background language on their interpretation of ambiguous English sentences forcing them to assign either surface scope or inverse scope.

The above considerations are somehow in close parallel with the findings reported in Musolino (1998), Young Kwak (2006) and Gennari and MacDonald (2005 /2006). Although the reported studies were mainly related to children interpreting the processing of QNPs with negation, they altogether highlighted the fact that there was strong preference to surface-scope interpretation over inverse-scope one and thus substantiating the reliability of the previous findings (Musolino, 1998; Musolino et al., 2000; Lidz and Musolino, 2002; Hye-Young Kwak, 2006). This indicates that SL learners' behavior concerning acquisition of QNP-NEG is the same phenomenon constrained by UG. In fact, through the positive evidence learners encountered by the input directing them to adopt surface-scope and / or inverse-scope and/or both, they can reset the parameter previously established. That is, the surface and/or inverse-scope interpretation of ambiguous sentences of the type QNP-NEG are justifiable from either by C-command relations in overt syntax – syntactic scope – triggered through Quantifier Raising/Quantifier Lowering as mentioned by (May, 1977 and 1985; Hornstein, 1995 among others) or by semantic scope referring to relative interpretation of the elements. It seems that the acquisition of QNP-NEG for L2 learners follows the same root as it does for L1 acquirers due to the fact their interlanguage grammar represents systematicity over time. Another issue which is noteworthy of consideration is the sensitivity to distributional patterns of language use as noted by Gennari and MacDonald (2005 and 2006). Their study indicated that the pairing of a sentence form with QNP-NEG and interpretation of it with one type of scope preference frequently – either surface or inverse – compel children to interpret negation in a manner that is isomorphic with the syntactic structure of the sentence. The findings confirm this since in Persian learners are most often encountered with surface wide scope in such constructions, this in time becomes their default and unmarked preference leading to ease of processing. Their answer of 50.84% in contextualized and 47.83% in acontextualized conditions in Persian stimuli validate the above assertions.

4.2. Influence of Surface Configurations of Sentences with QNP-NEG on Interpretation

The analysis of the data related to sentence configurations employing QNP-NEG reveals that in off-line tasks there was a significant difference in learners' interpretations of ambiguous sentences of English and Persian towards either wide scope assignment for quantifiers or negation element (QNP > NEG or NEG > QNP). Statistically speaking, in acontextualized conditions the participants selected 34.67% answers for English stimuli containing QNP-NEG which favored surface-scope and 65.33% indicating inverse-scope. Subjects' wide-scope

preferences concerning acontextualized Persian stimuli of QNP-NEG also favored surface-scope preference with 34% in which the quantificational element took wide scope over negation. The surface-scope percentages of 34.67% for English acontextualized stimuli and 34% for Persian acontextualized stimuli in off-line tasks indicated that the default and unmarked preference for L2 learners was the wide scope of the negative polarity item over quantifiers. In English and Persian stimuli which were biased with discursal contexts, the differences in surface and inverse-scope interpretations were not meaningfully significant emphasizing the role of contextual clues in ambiguity resolution. In on-line tasks, such a difference between surface and inverse-scope interpretations among the ambiguous Persian and English stimuli was not established. However, comparing the percentages of interpretation scores in off-line and on-line tasks illuminates this very fact that nearly in all conditions learners' preferences were favoring wide surface scope for quantificational element than negation. Exactly speaking, the percentage of 52.83 for wide surface scope of QNP > NEG in English stimuli in acontextualized condition and 47.83% for wide scope of quantifiers in comparison to negation in Persian stimuli – showing a slight change to off-line tasks being as 34% – highlights this point that subjects processed sentences according to the linear configuration orders of the constructions, i.e. the most leftward element is processed soon and takes wide-scope interpretation. Nonetheless, the extent of this difference was trivial and insignificant.

The findings of this study are partially consistent and partially inconsistent with that of the others reported in the literature. In a study conducted by Gennari and MacDonald (2005/2006) concerning the production and comprehension of negation and quantification for adult native speakers of English, it is suggested that “adults' experience with quantifiers, negation, and referential expressions does not promote the spontaneous production of ambiguous negative quantified statements or the perception of their being natural and acceptable” (p.114). This is also true for adult speakers of Persian when they encountered with Persian sentences incorporating a quantificational noun phrase and negation. It is also consistent with the findings of the study conducted on children by Musolino and Lidz (2003) who suggested that children's fragile pragmatic abilities and less sensitivity to pragmatic factors are the source of their inability to access non-isomorphic interpretations. They argued that, for example, in *Every duck didn't cross the river*, a Gricean implicature is required to access the non-isomorphic interpretation (Levinson, 1983): If the speaker meant that none of the ducks crossed the river, then he or she would have said so (this would be a better way to convey this information), therefore, he must mean that not all the ducks crossed the river. However, this inability of children in employing contextual and discursal references for interpretation of ambiguous constructions due to children's insensitivity was compensated by L2 learners due to their L1 experiences with pragmatic factors.

Taking all the data together, it seems that L2 learners are frequently exposed to surface phrasal and VP negation in English constructions such as *Everyone in the class doesn't speak two languages*, in which negation has semantic scope over syntactically dominated constituents, particularly indefinite objects referring to sets. This frequent pairing of sentence form and interpretation may compel them to interpret negation in a manner that is isomorphic with the syntactic structure of the sentence. Thus, the above sentence would receive an interpretation consistent with the logical sentential negation in which negation has scope over the indefinite reference *two*. However, in Persian the sentence, *Reza du estekân čâ-i næ-xord* (Reza didn't drink two cups of tea), the quantifier *two* (*du*) syntactically c-commands negation (*næ*) being attached to VP motivating one to interpret negation having wide scope over cardinal quantifier *du* (NEG > *du*). The repeated pairing of form and meaning determines speakers' default interpretation. Therefore, the distributional pattern identified is consistent with the literature on L2 learners' negation interpretation (Boysson-Bardies, 1977; Kim, 1985; Morris, 2003). Overall, whether quantifiers occur in the subject or object positions, they tend to be interpreted relative to negation or other quantifiers as having semantic scope isomorphic with syntactic scope.

Generally speaking, the above scope assignment possibilities can be tackled through the standard linguistic approaches, overt syntactic scope – that dictated by the surface c-command relations of the syntactic structure that defined by a different level of representation (LF) established via movement rules involving the fronting of quantifier element. It must be stated that in isomorphic or surface-scope interpretation, the semantic scope indicated by the order of the quantifier and negation in the logical translation is similar to that of the surface syntactic structure; whereas, in non-isomorphic or inverse-scope one it is the other way around.

4.3. Influence of Referential Contexts on QNP-NEG Interpretation

The analysis of the data concerning the effect of referential contexts of ambiguous sentences with QNP-NEG in English on interpretation preferences for SL learners indicated that in off-line tasks there was a significant difference between the score means of “Offline_AC_ENG_QNP_NEG_LF1” (M=8.32, SD=3.859) and “Offline_CC_ENG_QNP_NEG_LF1” (M=11.12, SD=3.789) representations; $t_{\text{obs}}(24) = -2.711$, $p = .012$. The results of the analysis show that the cost of assigning an inverse-scope interpretation observed in acontextualized

conditions of the same phenomenon persists even when that interpretation is supported by the preceding context. This fact suggests that the cost is not simply that of activating a lower-ranked or dispreferred interpretation, as a constraint-based model might predict. If that were the case, then we should expect the cost to be mitigated by a discourse context that supports the dispreferred interpretation and contributes to its activation, but in contextualized condition of the stimuli with QNP-NEG we observe the cost even with a supporting context.

Furthermore, the unambiguous stimuli used among ambiguous ones show that the inverse-scope interpretation incurs a cost even when it is the only possible interpretation. As Figure 1 shows, the sentence with QNP-NEG was read just as slowly when it was unambiguous 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 negated sentence with the quantifier. 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 sentences with QNP-NEG, difficulty which could not have arisen from competition with an alternative representation. These results therefore provide further evidence to support the idea that the cost of assigning inverse scope is a structural cost, arising from the greater complexity of the syntactic configuration of the inverse-scope representation.

However, the results of the on-line tasks concerning the effect of referential contexts of ambiguous sentences with QNP-NEG in English on interpretation preferences for SL learners indicated that there was no significant difference in the score means of "Online_AC_ENG_QNP_NEG_LF₁" (M=12.68, SD=1.887) and "Online_CC_ENG_QNP_NEG_LF₁" (M=12.24, SD=1.422) conditions; $t_{\text{obs}}(24) = 1.269, p = .217$. Nonetheless, to compare the difference in RTs of acontextualized and contextualized QNP-NEG stimuli in English, two t-tests were run. The first t-test revealed that there was a significant difference in mean RTs between "AC_ENG_QNP_NEG_LF₁" (M=12124.30, SD=14097.24) and "AC_ENG_QNP_NEG_LF₂" (M=17229.17, SD=11863.90) representations; $t_{\text{obs}}(299) = -5.123, p = .000$. Regarding RTs for contextualized QNP-NEG, it was also shown that the difference between mean RTs of "CC_ENG_QNP_NEG_LF₁" (M=7274.14, SD=10577.57) and "CC_ENG_QNP_NEG_LF₂" (M=10320.27, SD=16719.36) is significant; $t_{\text{obs}}(299) = -4.369, p = .000$. The results of both acontextualized and contextualized RTs in LF₁ and LF₂ clarify that LF₂, or inverse-scope representation, incurs processing difficulty to the parser. This could be the result of the greater structural complexity of the inverse-scope representation. However, it could also be the case that this processing difficulty arises simply because the inverse-scope interpretation is dispreferred (whether because it is less frequent or because it introduces more presuppositions than the surface-scope interpretation) and, therefore, the processor consumes more resources in activating this representation highly enough to select it (Figure 2).

The hypothesis that referential contexts of ambiguous sentences with QNP-NEG in Persian do not guide interpretation preferences for SL learners of English was rejected in off-line tasks. The computations through the paired t-test showed that there was a significant difference in mean scores of "Offline_AC_PER_QNP_NEG_LF₁" (M=8.16, SD=3.693) and "Offline_CC_PER_QNP_NEG_LF₁" (M=10.24, SD=2.847) conditions; $t(24) = -2.561, p = 0.017$. It means that semantically-referential contexts have played an effective role in ambiguity resolution of constructions with QNP-NEG in Persian. Although Persian was learners' native language, nonetheless one can notice semantic contexts functioning in resolving ambiguity. In acontextualized condition, learners selected 34% of answers favoring surface-scope / LF₁ representation; whereas it was 42.67% for surface-scope interpretation in contextualized condition. This shows that in Persian surface-scope interpretation incurs processing cost upon speakers and it is marked. In fact, the movement of negation constituent before quantificational constituent, as it was expected, did not cause the parser to encounter processing difficulty. The justification for this phenomenon in Persian may be the high frequency of LF₂ interpretations in contrast to LF₁. However, this difference was not objectified in on-line tasks.

Even though such a difference between surface scopes of acontextualized and contextualized conditions was not established for constructions with PER-QNP-NEG in on-line tasks the analysis of RTs carried out through paired t-test indicated that there was no significant difference in mean RTs of acontextualized condition between LF₁ (M=6473.02, SD=5298.09) and LF₂ (M=7368.51, SD=11474.85) representations; $t_{\text{obs}}(299) = -1.263, p = 0.208$. For the contextualized condition, the difference was not also significant between LF₁ (M=4094.7, SD=13842.78) and LF₂ (M=3595.4, SD=3722.84); $t_{\text{obs}}(299) = 0.597, p = 0.551$. In spite of the non-existence of differences in LF₁ and LF₂ representations' RTs, Figure 3 portrays the slight variances in RTs.

Beyond the fact that such variances were not established between LF₁ and LF₂ representations of ambiguous constructions in acontextualized and contextualized conditions, such an absence was also found for unambiguous constructions with QNP-NEG in Persian. This does not reject the Parallel Processing Model in Persian.

5. 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 and their interaction with negation operator 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-NEG 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.

References

- Altmann, Gerry T.M. and Steedman, M. (1988). Interaction with context during human sentence processing. *Cognition* 30: 191-238.
- Altmann, G., Garnham, A. & Dennis, Y. (1992). Avoiding the Garden Path: eye movements in context. *Journal of Memory and Language* 31. 685-712.
- Boysson-Bardies, B. de (1977). On Children's Interpretation of Negation. *Journal of Experimental Child Psychology* 23, 117-127.
- Chomsky, N. (2000). Minimalist Inquires: The Framework. In *Step by Step: Essays on Minimalist Syntax in Honor of Howard Lasnik*, eds. R. Martin, D. Michaels, and J. Uriagereka, Cambridge, MA: MIT Press.
- Chomsky, N. (2001). Derivation by Phase. In *Ken Hale: A Life in Language*, ed. M. Kenstowicz, Cambridge, MA: MIT Press.
- Crain, S. & Steedman, M. (1985). On not being led up the garden path: the use of context by the psychological syntax processor. In D.R. Dowty, L. Karttunen and A.M. Zwicky (eds.), *Natural Language Parsing: Psychological, Computational and Theoretical Perspectives*: 320-358. Cambridge: Cambridge University Press.
- Crain, S., & Thornton, R. (1998). *Investigations in Universal Grammar*. MIT Press: Cambridge
- Frazier, Lyn. (1987). Sentence Processing: A tutorial review. In M. Coltheart (ed.), *Attention and Performance XII: The psychology of reading*: 559-586. Hillsdale: Lawrence Erlbaum Associates.
- Frazier, L. (1990). Exploring the architecture of the language-processing system. In G.T.M. Altmann (ed.), *Cognitive Models of Speech Processing: Psycholinguistic and Computational Perspectives*: 409-433. Cambridge, Mass.: MIT Press.
- Frazier, L. & Clifton, C. Jr. (1996). *Construal*. Cambridge, Mass.: MIT Press.
- Frazier, L. & Fodor, J. D. (1978). The sausage machine: A new two-stage parsing model. *Cognition* 6: 291-325.
- Gennari, P. S., & MacDonald, M. C. (2006). Acquisition of Negation and Quantification: Insights from Adult Production and Comprehension. *Language Acquisition*.
- Heim, I. & Kratzer, A. (1998). *Semantics in generative grammar*. Malden MA: Blackwell.
- Hornstein, N. (1995). *Logical Form: From GB to Minimalism*. Oxford: Blackwell.
- Kim, K. J. (1985). Development of the Concept of Truth-Functional Negation. *Developmental Psychology* 21, 462-472.
- Kitagawa, Y. (1986). *Subjects in Japanese and English*. Amherst, University of Massachusetts.
- Koopman, H. & Sportiche, D. (1991). The position of subjects. *Lingua* 85: 211-58.
- Kuroda, S.Y. (1988) Whether we agree or not: a comparative syntax of English and Japanese. *Linguisticae Investigationes* 12: 1-47.

- Kurtzman, H. S. & MacDonald, M. C. (1993). Resolution of quantifier scope ambiguities. *Cognition* 48: 243-279.
- Levinson, S. C. (1983). *Pragmatics*, Cambridge University Press, Cambridge, England.
- Lidz, J. & Musolino, J. (2002). Children's Command of Quantification. *Cognition* 84, 113-154.
- MacDonald, M. C. (1994). Probabilistic Constraints and Syntactic Ambiguity Resolution. *Language and Cognitive Processes* 9(2): 157-201.
- Lotfi, A. R. (2006). Feature Sharing v. Feature Checking: An Analysis of Persian Pre- and Post-verbal CPs. *California Linguistic Notes* 31(1): 1-23.
- May, R. (1977). *The Grammar of Quantification*. Cambridge, MA, MIT.
- May, R. (1985) *Logical form: its structure and derivation*. Cambridge, Mass.: MIT Press.
- Montague, R. (1974). The proper treatment of quantification in ordinary English. In R. Thomason (ed.), *Formal Philosophy: selected papers of Richard Montague*: 247-270. New Haven: Yale University Press.
- Morris, B. J. (2003). Opposites Attract: The Role of Predicate Dimensionality in Preschool Children's Processing of Negations. *Journal of Child Language* 30, 419-440.
- Musolino, J. (1998). *Universal Grammar and the Acquisition of Semantic Knowledge: An Experimental Investigation into the Acquisition of Quantifier-Negation Interaction in English*. Doctoral Dissertation, University of Maryland at College Park.
- Musolino, J., & Lidz, J. (2003). The Scope of Isomorphism: Turning Adults into Children. *Language Acquisition* 11, 277-291.
- Musolino, J., Crain, S., & Thornton, R. (2000). Navigating Negative Quantificational Space. *Linguistics* 38, 1-32.
- Spivey, M. J. & Tanenhaus, M. K. (1998). Syntactic ambiguity resolution in discourse: Modeling the effects of referential context and lexical frequency. *Journal of Experimental Psychology: Learning, Memory and Cognition* 24: 1521-1543.
- Steedman, M. & Altmann, G. (1989). Ambiguity in context: a reply. *Language and Cognitive Processes* 4. 105-122.
- Tanenhaus, M. K., Spivey-Knowlton, M. J. & Hanna, J. E. (2000). Modeling thematic and discourse context effects with a multiple constraints approach: Implications for the architecture of the language comprehension system. In M.W. Crocker, M. Pickering and et al. (eds.), *Architectures and mechanisms for language processing* : 90-118.
- Thornton, R., Gil, M. and MacDonald, M. (1998). Accounting for crosslinguistic variation: A constraint-based perspective. In Hillert, D. editor, *Sentence processing: a crosslinguistic perspective*. Syntax and Semantics volume 31. San Diego, CA: Academic Press, 211-23.
- Thornton, R., MacDonald, M. and Gil, M. (1999). Pragmatic constraints on the interpretation of complex noun phrases in Spanish and English. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 256, 1347-65.
- Trueswell, J. C. (1996). The role of lexical frequency in syntactic ambiguity resolution. *Journal of Memory and Language* 35: 566-585.
- Trueswell, J. C. & Tanenhaus, M. K. (1994). Toward a lexicalist framework for constraint-based syntactic ambiguity resolution. In C. Clifton, L. Frazier and K. Rayner (eds.), *Perspectives on Sentence Processing*: 155-179. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Young K. H. (2006). Acquisition of the Scope Interaction Between Numeral Quantifiers and Negation in Korean : A Descriptive Study on Production and Comprehension. *Working Papers in Linguistics*, 37 (3): University of Hawai'i.

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.

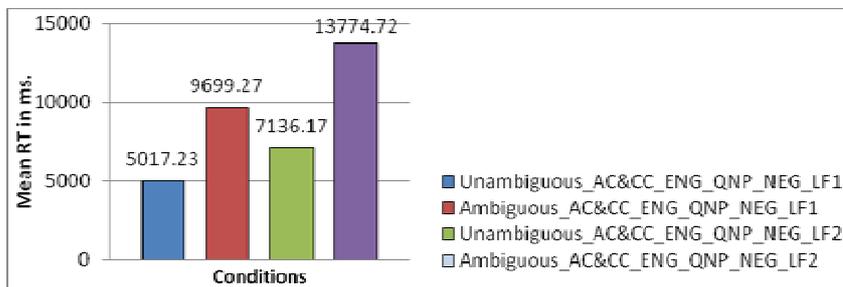


Figure 1. Mean Reading Times for Ambiguous and Unambiguous QNP-NEG in ms.

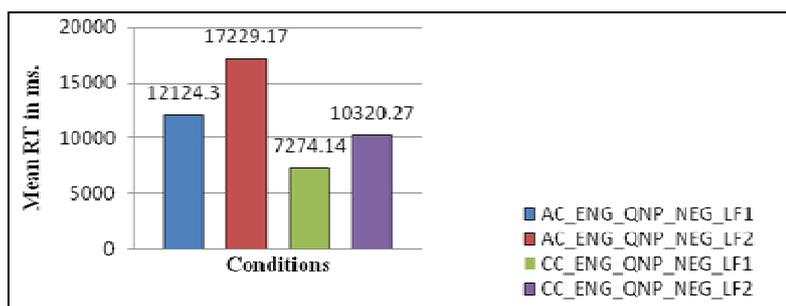


Figure 2. Mean Reading Times for ENG-QNP-NEG in ms.

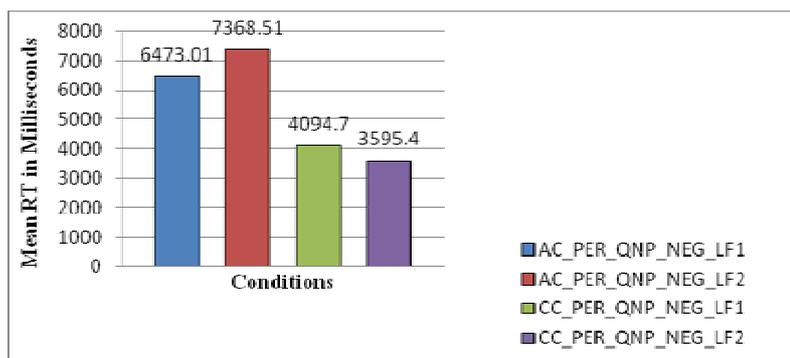


Figure 3. Mean Reading Times for PER-QNP-NEG in ms.