The prosodic structure of quantificational sentences in Greek

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1 Introduction

The sentence in (1) has been widely reported to have at least two interpretations (the most frequently cited early reference for such examples is Jackendoff 1972), shown in (1a) and (1b).

(1) *All the men didn't go*
a. 'No man went' (ALL > NOT)
b. 'Some men went' (NOT > ALL)

Each of these interpretations is realized with a different intonation of the sentence, what Jackendoff (1972), adopting Bolinger (1958) called contour A for (1a) and contour B for (1b). The meaning difference in (1a) and (1b) is attributed to different scope relations between *all* and *not*. These facts about the disambiguating effect of prosody in utterances involving scope as in (1) have been discussed many times in the literature (Jackendoff (1972), Ladd (1980, 1996), Steedman (1991, 2000), Büring (1997, 1999), among others).

Several issues arise in connection to such sentences: To begin with, it is not entirely clear in what way intonation is connected to the interpretation of sentences like (1). In other words, what is the rule or process that links the interpretation of such sentences to the way they are uttered? Furthermore, it is not clear how extensive this disambiguating effect of prosody is. Does it apply to sentences containing any type of quantifier, or is it restricted to some types only? Finally, no detailed experimental study of the exact nature of the prosodic structure of such utterances and its relation to the resulting meaning has been undertaken to my knowledge.

In this paper I address the issues just mentioned through an experimental study of the effects of intonation on quantificational sentences. The language under investigation is Greek. In this paper I present results from three experiments, each designed for different types of quantifiers. Each experiment consists of a production and a perception part: in the production part, the utterances of speakers producing the quantificational sentences were recorded and prosodically analyzed; in the perception part, listeners heard these utterances and were asked to give judgments about their meaning. The prosodic structure of the utterances that give rise to each of the interpretations was analyzed to determine which prosodic differences result in a different interpretation, and what prosodic features are consistently connected to each particular interpretation. A comparison across the different types of sentences in each experiment helped establish the prosodic regularities found in the structure of the utterances across the different types of quantifiers within a sentence.

The structure of the rest of this paper is as follows: In section 2 I present the first experiment, which examines sentences containing negation and an object quantifier. Section 3 offers an explanation for the connection between prosodic structure and scope interpretation, which is further developed in sections 4 and 5: In section 4 I present the

second experiment, which examines sentences containing a subject and an object quantifier. In section 5 I present the third experiment, which examines sentences containing negation and a 'because' clause. Section 6 is the conclusion.

2 Experiment 1: *Not* – object quantifier

In Greek, the interpretation of a sentence like (2), 'They didn't eat many apples' can be that given either in (2a) or (2b), depending on the intonation with which the sentence is uttered.

(2) *den efagan polla mila*
not ate-3pl many apples
a. 'The apples they ate are not many' [NOT>MANY]
b. 'There are many apples they didn't eat' [MANY>NOT]

In other words, a string like (2) is ambiguous only in written form in Greek; once it is uttered it is no longer ambiguous, since each of the two possible intonations gives rise to a different scope interpretation of the string.

In my first experiment, I looked at sentences like (2), to give experimental support to the claims made in the preceding paragraph. All the sentences contained negation, the word '*den*', and a DP containing a quantifier in object position. The experiment had two parts. In the production part, the speakers read aloud mini-dialogues containing these target sentences. The sentences they produced were analyzed to determine what kind of intonation was used for the delivery of the two meanings. In the perception part, listeners heard the target sentences out of context and had to decide what they mean based on their intonation alone. I present the production part of the experiment in section 2.1 and the perception part in section 2.2.

2.1 Production part

2.1.1 Method

8 speakers participated in the production part and read sentences in which the object quantifier varied among [*many, more than n, few, at most n*]. Word order also varied between VO and OV orders. Four different token sentences were used for each type of quantifier, resulting in 64 target sentences: 4 types X 4 tokens X 2 word orders X 2 question contexts. Each speaker only read one of the interpretations for each token sentence. The target sentences in (3A1) and (4A1) show the VO order and those in (3A2) and (4A2) show the OV order. Speakers were recorded reading aloud question answer pairs like (3Q-3A1) or (3Q-3A2) and (4Q-4A1) or (4Q-4A2).

(3) Q: *Posa provlimata elisan i mathites?*
how many problems solved the students
'How many problems did the students solve?'
A1: *Den elisan polla provlimata* [NOT > MANY]
not solved-3pl many problems-acc
A2: *Polla provlimata den elisan*
many problems-acc not solved-3pl
'The problems they solved are not many'

(4) Q: *Posa provlimata den elisan i mathites?*
how many problems not solved the students
'How many problems didn't the students solve?'
A1: *Den elisan polla provlimata* [MANY > NOT]
not solved-3pl many problems-acc
A2: *Polla provlimata den elisan*
many problems-acc not solved-3pl
'The problems they didn't solve are many'

One way of thinking about the difference in meaning between the target utterances in (3A) and those in (4A), is to say that the sentences in (3A) are about the number of problems solved by the students, whereas those in (4A) are about the number of problems *not* solved by the students. The questions preceding the target sentence in each of the examples serve the purpose of triggering these two different meanings: In (3Q) the question is 'How many problems did the students solve,' but in (4Q) the question is 'How many problems didn't the students solve.' The hypothesis in this production part of the experiment was that a different intonation would be used by speakers to deliver each of these two meanings.

As already mentioned, exactly the same two questions, (3Q) and (4Q) were used as triggers for target sentences with OV word order like those in (3A2) and (4A2). Word order was varied in the target sentences to examine (a) whether a change in word order would affect the interpretation of these sentences and—whatever meaning results from the word order change--(b) whether a change in word order would affect the intonation used to deliver such meaning.

2.1.2 Results

There were two distinct intonation contours produced per sentence, one for each interpretation, confirming the experimental hypothesis. The prosodic analysis presented here follows the framework for the analysis of Greek prosody presented in Greek ToBI (GrToBI, Arvaniti & Baltazani 2000). Figure 1 shows the pitch track of an utterance produced in the experiment. In all figures of pitch tracks there are three parts: (a) the top part contains text with annotations for the prosodic analysis in terms of pitch accents (e.g. L+H*) and boundary tones (eg. L-H% in the 'tones' tier), the transliterated Greek text of the utterance in the second tier ('words' tier), the word-for-word gloss in the third tier ('gloss' tier), and the scope relation between the two quantifiers in the fourth tier ('scope' tier); (b) the middle part shows the waveform of the utterance; and (c) the bottom half shows the continuous line with peaks and valleys which is a record of how pitch (in Hz) changes across time (in ms.) throughout the utterance. The black vertical lines show how the waveform and pitch track align with the ends of words.

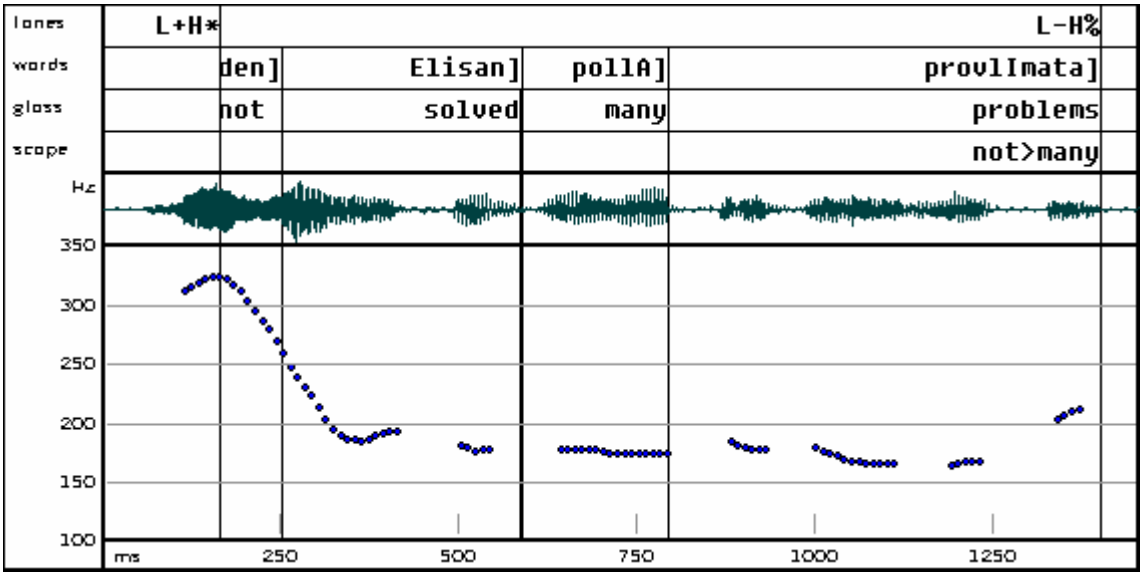

Figure 1. Pitch track for the sentence 'The problems they solved were not many' [NOT > MANY]. The word 'NOT' is aligned with the focus nuclear pitch accent, L+H*. All post-nuclear words are de-accented, that is they carry no pitch accents, but instead form a low plateau.

In the utterance shown in Figure 1, the highest and only peak aligns with negation, the first word. This word is focused and carries a L+H* focus nuclear pitch accent. All the words following it are de-accented, that is they carry no pitch accent, forming a low plateau. This utterance was produced as an answer to 'How many problems did the students solve?' The meaning we expect this utterance to convey in the perception experiment is negation wide scope.

In figure 2, we see the same string uttered with different prosody, in response to the question 'How many problems didn't the students solve?'

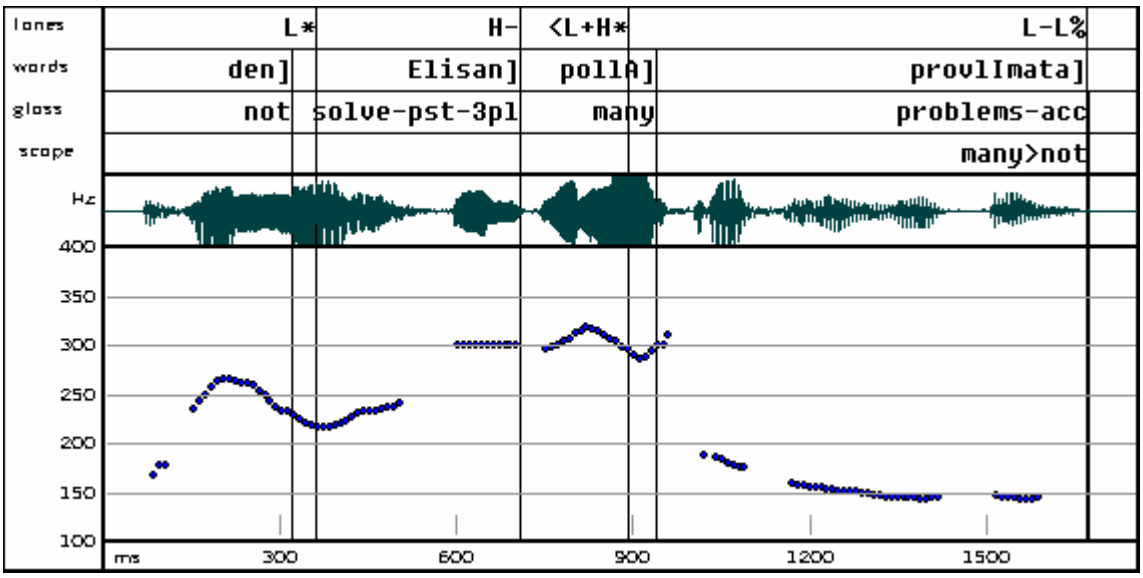

Figure 2. Pitch track for the sentence 'The problems they didn't solve were many' [MANY > NOT]. The word 'MANY' is aligned with the focus nuclear pitch accent, L+H*.

The meaning we expect this utterance in Figure 2 to convey is quantifier wide scope. The quantifier *many* aligns with the highest peak; it is focused, carrying a L+H* nuclear pitch accent. The word *not* forms a separate prosodic phrase together with the verb, which precedes the prosodic phrase containing the quantifier. The two prosodic phrases are separated by a H^- tone boundary. The phrase formed by the negation plus verb has the intonation characteristic of topic phrases in Greek (Baltazani & Jun (1999)).

The example pitch tracks in Figures 1 and 2 illustrate the two prosodic patterns that were consistently used by all speakers and in both word orders, each in response to the different question preceding the target sentence[1]. In both of these patterns, prosodic focus aligns with the quantifier we expect to receive wide scope interpretation. The narrow scoping quantifier forms the prosodic ground part of the utterance, either becoming de-accented, as shown in Figure 1, or a prosodic topic phrase, as shown in Figure 2. The generalization that emerges from the prosodic analysis of the utterances produced in this part of experiment 1 is the following:

- Wide scope = prosodic focus
- Narrow scope = prosodic background

Speakers in general produced these two different intonation patterns across quantifiers, and also across word orders. That is, every string was uttered in two different ways in response to the two different questions preceding it, regardless the word order. In general, 51/64 (79.7%) of the sentences that speakers produced successfully used intonation to distinguish between the two scope interpretations.

2.2 Perception part

2.2.1 Method

The aim of the perception experiment was to determine whether listeners can distinguish between the two scope interpretations of the ambiguous strings based only on the intonation of the given utterance, without any context. 42 listeners participated in this part of the experiment. They heard the utterances out of context and each participant heard only one intonation of each token sentence. The listeners' task after listening to each utterance was to decide which one of 5 answers given to them best matched the utterance meaning. The five choices were presented to the listeners in the form of a table, like the one shown in Figure 3, and they had to circle the best answer. Listeners were shown examples illustrating their task at the beginning of the perception experiment.

[1] Space considerations prevent me from showing examples of pitch tracks of utterances in the OV word order, but these have exactly the same prosodic realization as the examples shown for the VO order.

Solved	**Not solved**
A **2**	B **2**
C **20**	D **20**
E **VAGUE**	

Figure 3. Example of the table given to listeners for the perception task.

The table with the five choices always had the form of the one in Figure 3; the only element varying was the verb in the top cell, which matched the verb of each particular utterance the listeners heard. There are two columns, the left one labeled with the affirmative form of the verb and the right one with the negative form of the verb, in the case of the example in Figure 3, 'solved' and 'not solved'. In each of the columns there are two cells with numbers: 2 at the top cells, representing a small quantity and 20 at the bottom cells, representing a large quantity, and this convention was explained to the participants at the beginning of the perception test. Answer A represents the meaning 'small quantity solved', answer C 'large quantity solved', answer B 'small quantity unsolved', and answer D 'large quantity unsolved'. Answer E is there for sentences that listeners might find unclear.

Let us go through an example of what listeners were actually predicted to do. First, listeners hear the utterance '*den elisan polla provlimata*' (= not solved many problems) with focus on negation. If they interpret this as negation wide scope then they should choose answer A, that is, 'the problems they solved are not many.' Second, listeners hear the utterance with focus on the quantifier. If they interpret this as quantifier wide scope they should choose answer D, that is, 'the problems they did not solve are many'. Answers B and C are irrelevant for this sentence but should be used with decreasing quantifiers, like 'few'. Answer B then would represent the meaning 'the problems they did not solve are few' (few > not) and answer C, 'the problems they solved are not few' (not > few).

The hypothesis in this part of the experiment is that listeners will interpret the focused element as having wide scope and the back-grounded one as having narrow scope.

2.2.2 Results

Listeners interpreted the two prosodic structures differently from one another for most cases[2], confirming the hypothesis. A table with the detailed results of the perception experiment is given in the Appendix. To give an example, for the quantifier 'many,' 54%

[2] There are some exceptions to this generalization, mostly involving decreasing quantifiers in the OV order, as can be seen in the detailed results in the Appendix, but discussion of these cases cannot be included in this paper in the interest of space.

of the responses were correct in the VO order and 47.5% for the OV order[3]. Incorrect responses were 21% for the VO order and 30.4% for the OV order, below significance. The remaining of the responses fell in the 'unclear sentence' category. Responses were labeled 'correct' when listeners interpreted the quantifier that was focused as the one taking wide scope and 'incorrect' when listeners interpreted the non-focused quantifier as the one taking wide scope.

In general, summing up the results in both the production and perception parts of experiment 1, speakers encoded and listeners understood wide scope through prosodic focus. Why is that? What is the connection between prosodic focus and wide scope interpretation? In the following section I offer an explanation for the connection between the two.

3 Information structure

There is a long line of research which links the prosodic realization of an utterance with its pragmatic function in a given context (Jackendoff (1972), Steedman (1991, 2000), Rooth (1992, 1996), Vallduví (1992), Selkirk (1995), Roberts (1996), Vallduví and Engdahl (1996), Büring (1997b, 1999), Schwarzschild (1999), among others). This pragmatic function is expressed in terms of the information structure of the utterance, that is, the new-old information division. Giving a formal account of the link between prosody and pragmatic interpretation is beyond the scope of this paper, but different formalizations of it can found in Steedman (1991, 2000), Rooth (1992, 1996), Büring (1997b, 1999, to appear), Schwarzschild (1999). The heuristic of question-answer congruence is employed in many of these studies to aid the definition of notions like focus and background. According to this heuristic, focused constituents in the answer address information requested by the question, and back-grounded constituents repeat information already present in the question, as shown schematically in Figure 4. In this sense, only answers whose prosodic structure adheres to this heuristic are seen as 'congruent', that is, as appropriate answers.

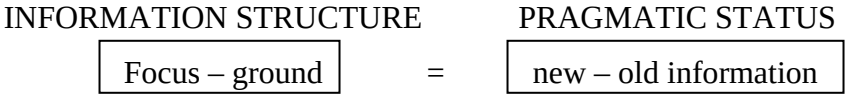

Figure 4. The link between prosodic structure and information structure

We can informally describe the function of prosodic structure as employing the process of question-answer congruence at the listener's end: listeners perceiving the prosodic structure of an utterance can separate the parts of it that are new information—the ones prosodically focused—from the parts that are old information—the back-grounded parts. In this way, listeners are able to reconstruct the context of the utterance, even when this is not explicit. Context is assumed in this paper to be the question to which the utterance is an answer to, or the Question Under Discussion (QUD), but nothing in the account given here hinges on such a definition of context. Context can come in many forms, only one of which assumes the form of a question. QUDs are only employed here as a matter of convenience.

[3] Notice that in their task listeners had basically three choices, each one with a probability of 33%: (a) focus = wide scope, (b) focus = narrow scope and (c) sentence unclear. Any response above 33% counts as significant and both these numbers are much above 33%.

Let us return now to the process by which listeners can use prosodic information of an utterance to infer its meaning. If a phrase is focused in any given utterance, then according to the 'focus = new information' equation shown in Figure 4, listeners can infer that this phrase was not part of the context/QUD. Correspondingly, if a phrase is back-grounded in an utterance, then according to the 'ground = old information' equation, listeners can infer that this phrase was part of the context/QUD. It is evident that different focus-ground divisions of the same string make that string a congruent/ appropriate answer to different questions.

Assuming this connection between prosodic structure and information structure, let us look once more at the experimental sentences. In (5) and (6) I show the prosodic marking of the same two experimental utterances we have been looking so far. The focused word is shown in capital letters and marked with the subscript 'F'; the topic phrase is marked with the subscript 'TOPIC'; unmarked portions of the sentence are assumed to be part of the background. In (5) the negation is in focus, by which listeners can infer that negation is new information, which in turn implies that the negation was not part of the question. Listeners then can infer that the context question has to do with the quantity of solved problems and can be expressed as something like 'How many problems did they solve?' Here is the chain of inference for (5): 'not'= focus → 'not'= new → 'not' is absent from QUD → QUD: 'How many problems did they solve?' The answer to this question, shown in (5), will have the scope interpretation shown (NOT>MANY): the verb is interpreted having positive polarity, just like the verb in the context question, and the negation then is free to scope over the quantifier *many*.

(5) *[DEN]$_F$ elisan polla provlimata* [NOT>MANY]
not solved many problems

On the other hand, in (6), negation is back-grounded, therefore it is old information and as such part of the question under discussion, which is about the quantity of unsolved problems, something like 'How many problems didn't they solve?' Chain of inference for (6): 'not' = ground → 'not' = old → 'not' is present in the QUD → QUD: 'How many problems didn't they solve? The negation here cannot scope over the wh-word neither in Greek nor in English (weak island effect), hence the MANY > NOT interpretation.

(6) *[Den elisan]$_{Topic}$ [POLLA]$_F$ provlimata* [MANY > NOT]
not solved many problems

Notice that both in (5) and (6), it is the questions under discussion that help set the scope interpretation of the answer. In other words, the accent pattern of an utterance is not directly related to scope interpretation, according to the account given here. The accent pattern has to do with the information structure of the utterance but can be indirectly linked to scope interpretation through context. As we will see in the following section, this indirect link between prosody and scope interpretation can only obtain under the right circumstances: if the context of the ambiguous quantificational sentence is not of the right kind, prosody cannot help in the disambiguation of scope interpretations. Section 4 presents the second of three experiments. In this experiment we see that even though the link between prosody and information structure holds in the same way it did for the utterances in experiment 1, the next link in the chain—that between information

structure and scope interpretation—is broken and as a result prosody cannot help disambiguate scope.

4 Experiment 2: Subject and object quantifier

In the second experiment, I examined sentences that contained two DP quantifiers, in subject and object position, without any negation. There were two parts in this experiment, a production and a perception one, as in the first experiment.

4.1 Production part methods and results

Eight speakers participated in the production part reading a total of 200 sentences (5 quantifier pairs [*few-every*, number-number, *every*-number, *many-at least, most-some*] X 2 positions for each quantifier in the pair [subject or object[4]] X 3 word orders [SVO, OVS, and O-clitic-VS] X 2 locations of focus [subject or object] X 4 token sentences for each quantifier pair[5]). The speakers were divided in four groups of two, each group reading 50 out of the 200 sentences, to make their task more manageable, and also to expose them to one prosodic version of each token sentence.

The mini dialogs in (7) and (8) are examples of the question answer pairs that were used as triggers for two different intonations in this experiment. For these examples too I have labeled the focused and topicalized phrases in the answers to facilitate discussion. In (7) the question is 'How many nurses helped every doctor?' and in the answer the focus is the word *treis* (= 'three'), which answers the wh-word *poses* (= 'how many'); the rest of the material in the answer is old information, and therefore it is back-grounded (de-accented). The utterances produced have exactly the same prosodic shape as the sentences in experiment 1, but unfortunately cannot be shown here for lack of space[6].

(7) Q: *Poses* *nosokomes* *voithisan* *kathe* *giatro?*
how many nurses-nom helped every doctor-acc
'How many nurses helped every doctor?'
A: *[TREIS]$_F$ nosokomes voithisan kathe giatro*
three nurses helped every doctor
'Three nurses helped every doctor'

In (8) the question is 'How many doctors did three nurses help?' The answer in (8) is string identical to the answer in (7), but has a different accent pattern: the object quantifier *kathe* (= 'every') is focused this time since it answers the wh-word *posous* (= 'how many'). The rest of the answer is back-grounded because it is old information.

(8) Q: *Posous* *giatrus* *voithisan* *treis* *nosokomes?*
how many doctors-acc helped three nurses-nom
'How many doctors did three nurses help?'
A: *[Treis nosokomes]$_{TOP}$ voithisan [kathe]$_F$ giatro*
three nurses helped every doctor

[4] For example, in the *few-every* pair, I constructed sentences with *few* in subject position and *every* in object position, and also the same sentences with *every* in subject position and *few* in object position.
[5] The total comes to 240, but for the O-cl-VS sentences only one prosodic structure is possible, namely focus on the subject, which brings the total of sentences down to 200.
[6] I will be happy to provide pitch tracks and sound files from my experiments to anyone interested. I can be contacted at marybalt@ucla.edu.

'Three nurses helped every doctor'

As we see, the link between prosodic structure and information structure holds for these utterances just like it did for utterances in the first experiment. The location of the prosodic focus and background in the utterances is regulated here as well by which parts of the utterances are new and which old. Most of the sentences produced (79%) used this prosodic structure for the utterances[7].

The next question we need to answer in this experiment is whether this prosodic structure helps disambiguate the scope interpretation. More concretely, the hypothesis for the perception part is that the focused phrases will be interpreted by listeners as having wide scope and back-grounded ones as having narrow scope. The perception part of the experiment was conducted to test this hypothesis.

4.2 Perception part method and results

92 listeners participated in this part of the experiment, divided in five groups. The sentences were also divided in five parts of 40 sentences each, one part for each group of listeners, to make their task easier. Each group heard the same type of sentences but different tokens for each type.

The listeners' task was to choose one of four answers given to them as interpretations of the sentences. For a sentence like (9), the questions corresponding to it looked like the ones shown in Figure 5. Recall that the working hypothesis is that scope interpretation in this sentence is [3 > *every*] when *3* is focused, and [*every* > 3] when *every* is focused. All sentences were followed by questions like the ones shown in Figure 5, where the two possible scope interpretations were represented by graphs similar to the ones in Figure 5 as answers A and B, and two more answers were included, C for utterances judged by listeners to have neither subject nor object wide scope, and D for utterances that were unclear to listeners.

(9) *Treis nosokomes voithisan kathe kardiologo*
three nurses helped every cardiologist

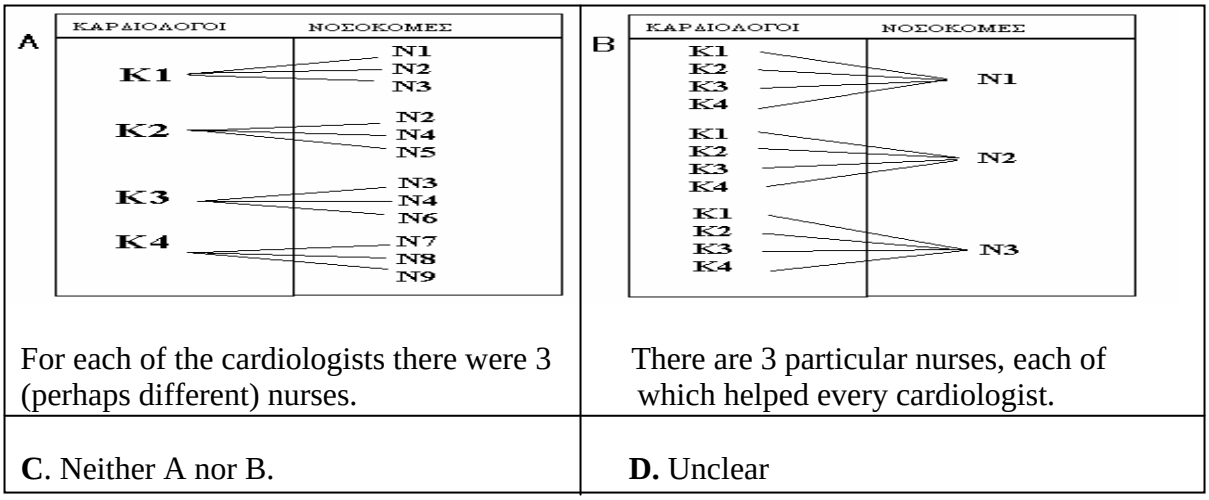

Figure 5 Example of the choice of answers corresponding to sentence (9) for the perception part of experiment 2.

[7] For the rest of the utterances (21%) there were usually disfluencies which disrupted the prosodic structure, or speakers used very marked ways to produce them, such as emphasizing every single word.

In the perception part of this experiment, however, listeners did not interpret the focused item as wide scope. Only 32% of the times was focus judged to take wide scope. Listeners interpreted subjects as taking wide scope, except in the O-cl-VS order where the clitic doubled object consistently received wide scope interpretation, effects that have already been noticed in the literature (see Alexiadou & Anagnostopoulou (1998), Giannakidou (1997) among others).

4.3 Discussion

The crucial question in this experiment is, of course: Why didn't intonation help here like it did in experiment 1? The answer, I believe, lies with the context questions. Let us take another look at the context questions of both experiments, repeated below. The questions in experiment 1, questions (3) and (4), were different from those in experiment 2, questions (7) and (8):

(3)	How many problems did they solve?	EXPERIMENT 1
(4)	How many problems didn't they solve?	EXPERIMENT 1
(7)	How many nurses helped every doctor?	EXPERIMENT 2
(8)	How many doctors did three nurses help?	EXPERIMENT 2

The context questions in experiment 1 are not ambiguous: (3) asks about solved problems, so in the answer the polarity of the verb is positive too, and the negation scopes over the quantifier instead. (4) is unambiguous in Greek, as well as in English, since the negation cannot scope over the wh-word (a weak island effect). On the other hand, the context questions (7) and (8) are ambiguous in Greek, and also in English: they could be about counting nurses each of which has the property of helping every doctor, or about counting the nurses by doctor, each doctor having a different group of nurses helping her.

The hypothesis made initially about the indirect connection between scope interpretation and prosody through information structure predicts exactly this difference in the experimental results between experiments 1 and 2: in experiment 1, listeners can proceed from prosodic structure to information structure to scope calculation, based on the unambiguous context questions. In experiment 2, the same chain of inference cannot result in scope disambiguation since the potential source of disambiguation, the questions, are ambiguous themselves. More evidence for this chain of inference comes from the third experiment I conducted, described in the following section.

5 Experiment 3: *Not – Because*

This experiment examined sentences containing negation and a *because* clause. There was a production and a perception part to this experiment too.

5.1 Production method and results

There were 10 contexts created aiming at the production of 10 unambiguous utterances (5 sentences X 2 prosodic structures). Five speakers read two of the contexts each. Examples of disambiguating contexts are given in (10) and (11).

In (10) the question is 'why is he watching TV' and the answer is 'not because he's bored' (i.e., '…but maybe because there's something interesting on'). Again it turns

out that speakers put the focus on negation because this is new information and de-accented the rest of the material because it is old information.

(10) Q: *Giati vlepei tileorasi? Variete?*
why watch-3s TV is bored
'Why is he watching TV? Is he bored?
A: *[Den]*$_{F}$ *vlepei tileorasi giati variete* [NOT > BECAUSE]
not watch TV because is-bored
'He's not watching TV out of boredom'

In (11), the question is 'why isn't he watching TV?' and accordingly speakers back-grounded negation because it is old and focused the *because* clause because it is new. All speakers used these two prosodic structures—as in all experiments—to disambiguate the sentences.

(11) Q: *Giati de vlepei tileorasi?*
why not watch-3s TV
'Why isn't he watching TV?'
A: [*Den vlepei tileorasi]*$_{TOP}$ *[giati variete]*$_{F}$ [BECAUSE > NOT]
not watch TV because is-bored
'The reason he's not watching TV is because he's bored'

5.2 Perception method and results

27 listeners participated in the perception part of experiment 3. Their task was to choose one of two answers following a simple question related to the utterances meaning, shown in (12).

(12) *Vlepei tileorasi*?
"Is he watching TV?"
a. *Ne* "Yes" [NOT > BECAUSE]
b. *Ohi* "No" [BECAUSE > NOT]

The reasoning behind a question like (12) is that the difference between the two scope interpretations of (10) and (11) has to do with whether negation scopes over the matrix verb: if the matrix verb has a positive polarity interpretation, then negation scopes over the 'because' clause (answer (12a)); otherwise it scopes under the 'because' clause (answer (12b)).

Listeners distinguished between the two interpretations, even out of context. Recall that an answer counts correct when the focused item is interpreted with wide scope. When *not* was focused, 117/135 listeners (86.67%) interpreted it as having wide scope and when focus was in the *because* clause, 132/135 listeners (97.78%) interpreted *because* as having wide scope. It is clear that listeners differentiated very successfully between the two interpretations based on intonation alone.

6 Summary

Summarizing the results of all three experiments, we saw that in the two experiments where negation was involved, listeners worked their way from the accent pattern to information structure to scope interpretation. In exp. 3 and 1, context questions are unambiguous, therefore the indirect link between prosody and scope holds. Listeners can 'reconstruct' the context from the prosodic pattern of the utterance. Furthermore in both these experiments it is the lack of ambiguity in the context questions that allowed for focus to be interpreted as wide scope.

Crucially, however, as shown by experiment 2, the prosodic structure of utterances has nothing to do with a scoping mechanism per se. Intonation only gives information about the context in which a sentence can be appropriately uttered. When the context doesn't help set the scope, intonation only tells us which quantifier is old information and which is new, not which quantifier takes wide scope.

Appendix

These are the results from the perception part of Experiment 1. Results are presented by quantifier in four separate tables, 1 - 4. Results are given both in absolute numbers and percentages. The first column, 'Focus,' shows which quantifier carried prosodic focus. The second column, 'Correct,' shows the number of answers in which the item aligned with prosodic focus was judged to have wide scope. The third column, 'Incorrect,' shows the number of answers in which the item aligned with prosodic focus was judged to have narrow scope. The fourth column 'Vague' shows the number of answers for which listeners could not understand or could not decide upon a meaning.

Notice that all three answers in the three columns 'Correct,' 'Incorrect,' and 'Vague' are equi-probable, so any percentage above 33% is considered 'above chance'.

ORDER	FOCUS	CORRECT (%)	INCORRECT (%)	VAGUE (%)	TOTAL
OV	NEG FOC	30/68 (44%)	27/68 (40%)	11/68 (16%)	68
	Q FOC	35/68 (51%)	21/68 (31%)	12/68 (18%)	68
VO	NEG FOC	42/68 (62%)	20/68 (29%)	6/68 (9%)	68
	Q FOC	31/68 (46%)	22/68 (32%)	15/68 (22%)	68

Table 1: 'Many' responses

ORDER	FOCUS	CORRECT (%)	INCORRECT (%)	VAGUE (%)	TOTAL
OV	NEG FOC	30/68 (44%)	20/68 (29%)	18/68 (26%)	68
	Q FOC	42/68 (62%)	9/68 (13%)	17/68 (25%)	68
VO	NEG FOC	38/68 (56%)	16/68 (24%)	14/68 (21%)	68
	Q FOC	26/68 (38%)	27/68 (40%)	15/68 (22%)	68

Table 2: 'More than' responses

ORDER	FOCUS	CORRECT (%)	INCORRECT (%)	VAGUE (%)	TOTAL
OV	Q FOC	37/136 (27%)	77/136 (57%)	22/136(16%)	136
VO	NEG FOC	36/68 (53%)	10/68(15%)	22/68(32%)	68
	Q FOC	23/68 (34%)	37/68(54%)	8/68(12%)	68

Table 3: ‘Few’ responses

ORDER	FOCUS	CORRECT (%)	INCORRECT (%)	VAGUE (%)	TOTAL
OV	Q FOC	35/136 (26%)	74/136 (54%)	27/136(20%)	136
VO	NEG FOC	21/68 (31%)	9/68(13%)	38/68(56%)	68
	Q FOC	20/68 (29%)	24/68(35%)	24/68(35%)	68

Table 4: ‘At most’ responses

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