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KVANTOROK HATÓKÖRI KÉTÉRTELMŰSÉGÉNEK KÍSÉRLETES VIZSGÁLATA A MAGYARBAN

Doktori (PhD) értekezés

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QUANTIFIER SCOPE AMBIGUITIES IN HUNGARIAN
AN EXPERIMENTAL APPROACH

PhD dissertation

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Nagyszüleimnek

DOI: 10.15774/PPKE.BTK.2020.021

TABLE OF CONTENTS

DOI: 10.15774/PPKE.BTK.2020.021

DOI: 10.15774/PPKE.BTK.2020.021

DOI: 10.15774/PPKE.BTK.2020.021

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DOI: 10.15774/PPKE.BTK.2020.021

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DOI: 10.15774/PPKE.BTK.2020.021

ABSTRACT

This thesis experimentally investigates scope interpretation of sentences containing two quantified expressions (also known as "doubly quantified" sentences) in Hungarian. Doubly quantified sentences, exemplified in English in (1) below, are potentially ambiguous. They often have two different readings, as a function of the two relative scopal interpretations of the quantifiers they contain.

(1) [$_{QP1}$ Exactly two students] did [$_{QP2}$ each assignment].
   a. 'Exactly two students are such that they did each assignment.' QP1 > QP2
   b. 'Each assignment is such that it was done by exactly two students.' QP1 < QP2

The scope reading (dis)preference of the available readings are known to be influenced by many linguistic and extra-linguistic factors. Among these, the main linguistic factor is word order, and more precisely, syntactic structure. The classic view is restricted to the hypothesis that the available readings always originate only from the syntactic representations. According to this view, the other factors have only an indirect effect on the scope readings via the syntactic module, since these factors affect the syntactic representations and not the scope readings. This model is known as the Y model, which postulates only one interface between grammar and semantics: this is syntax.

Two main linguistic factors that have been suggested in previous literature to affect scope readings are prosody and information structure. However, it is not clear to what extent these effects can be taken to be real, and if so, whether or not they function independently of each other. What is more, prosody and information structure are clearly interrelated not only with each other but with syntax as well.

The aims of the thesis are teasing apart of the following issues:

(i) Are the supposed effects of prosody and information structure on scope reading real, and if so, do they affect scope independently, and what are their concrete effects?

(ii) Is it necessary to extend the Y model with further interfaces such as prosody–semantics (scope) or information structure–semantics(scope) for the explanation of any newly found effects?

This dissertation carefully investigates the above questions by means of nine experiments. Two main types of experiments have been carried out. In the first type, I investigated the effect of

DOI: 10.15774/PPKE.BTK.2020.021

prosody with null textual context but with images representing the different scope readings. There were production experiments involving doubly quantified sentences (Exp1) and two types of negative sentences applied to investigate the scope relations between the negative particle and a bare numeral NP (Exp2), and the negative particle and a quantifier (Exp3A). The latter one was complemented with an acceptability judgment task (Exp3B) as well. Exp1 found no effect of scope on the prosodic realization of doubly quantified sentences. The results of negative sentences showed a relation between the two prosodic realizations and the two scope readings in both experiments.

The second main type of the experiments (ii) explored the effect of information structure in a controlled, written context in the case of the doubly quantified sentences in production (Exp4A), perception (Exp4B), and in acceptability (Exp5A, B, C). According to the findings of these experiments, prosodic differences reflect only the different information structural status of the quantifier, and they do not have a direct effect on the scope taking behavior of the quantifier. Furthermore, I found that not even information structural status, namely focus or given status, has an effect on scope relations, since both scopal readings were available for both focused and given quantifiers. I argue that this is because the QP being targeted by the question under discussion (QUD) – in other words, the focused element – is allowed to have either narrow or wide scope as part of the QUD in the doubly quantified sentences at issue.

As for the apparent link between different prosodic realizations and scope readings in negative sentences (Exp2, Exp3A), I suggest that the detected prosodic difference between them is merely a reflection of an information structural difference in the main focus of the sentence. The reason why this difference, in turn, results in a scopal difference in negative sentences lies in the scopal options available in the QUDs that these sentences answer. Specifically, QUDs in which the targeted element (negation or the quantified phrase) bears narrower scope are excluded due to independent properties of negation. On the surface, this results in each of the two types of QUDs licensing only one scope reading, creating the illusion that there is a link between prosodic realization and scope.

Summarizing the results, it can be stated that there is no independent effect of prosody on the scope reading. Prosody only reflects the information structural roles and helps the hearer to reconstruct the question under discussion. Therefore there is no need to postulate a direct interface between the semantic and phonetic modules. Furthermore, there is no need to postulate a direct mapping between information structure and scope relations either, since in the case of the carefully controlled information structure I found no effect of the information structural status of the quantifier on its scope taking behavior. In sum, the classic Y model can be maintained.

DOI: 10.15774/PPKE.BTK.2020.021

1 INTRODUCTION

1.1 The issue

Doubly quantified sentences — as presented in (1) — potentially have more than one reading. The first, and probably the more straightforward interpretation of the sentence is given in (1.a). In this case, the sentence describes a situation in which two specific students (e.g. Anna and Ben) were able to hand in each assignment during a course. No one else from the class could repeat this success. On the other hand, the reading paraphrased in (1.b) depicts a rather different scenario. In this situation each assignment was completed by only two — potentially different — students: e.g. the first week assignment was done by Anna and Ben; the second week assignment was finished by Cecilia and Daniel; while the third week assignment was handed in by only Ernest and Frank — and so on and so forth until the end of the semester.

(1) [$_{QP1}$ Exactly two students] did [$_{QP2}$ each assignment].
   a. ‘Exactly two students are such that they did each assignment.’
   b. ‘Each assignment is such that it was done by exactly two students.’

Ambiguity arises because the interpretation of the two quantifiers can interfere in such sentences. In (1.a) the quantificational phrase (henceforth: QP): *exactly two students* is considered first and the second QP: *each assignment* is rendered to the first QP. The scope reading in (1.a) respects the linear order of the QPs, namely the interpretation is isomorphic to the word order of the sentence, henceforth (1.a) is the so called *linear scope reading* of the sentence. In this interpretation, QP1 has QP2 in its scope, i.e. QP1 has wide scope over QP2 and QP2 has narrow scope in the sentence. On the other hand, (1.b) shows just the opposite: QP1 is interpreted with respect to QP2. The linear order of the QPs does not reflect the order of their interpretation; henceforth (1.b) is the so called *inverse scope reading* of the sentence. In (1.b), QP2 scopes over QP1, hence QP2 obtains wide scope, while QP1 takes narrow scope in the sentence.

(1.a) Linear scope: QP1 exactly two: wide scope
QP2 each: narrow scope

DOI: 10.15774/PPKE.BTK.2020.021

(1.b) Inverse scope: QP1 exactly two: narrow scope
QP2 each: wide scope

In (1.a), QP1 is the sorting key, while QP2 is the distributed share: it lists the two students and assigns each completed assignment to him/her. This interpretation is the *distributive scope reading* of the quantifiers. It has to be noted that there is also an existential scope reading available for such quantifiers (see Section 2.1.2 for further details), however, this thesis focuses on the distributive scope interpretation.

Not all doubly quantified sentences are unequivocally ambiguous. There are many grammatical and extra grammatical factors that affect scope reading of the distributive universal quantifier. Syntactic structure can bias the scope reading preferences. In cases where both linear and inverse scope interpretations are available, the linear reading is always preferred to the inverse scope reading, i. e. the quantifier uttered earlier gets wide scope more easily (see among others: Ioup 1975, Fodor 1982). There are many empirical studies concerning processing that have proved this phenomenon (for Hungarian see: Gyuris and Jackson 2018). In the field of syntactic theory, there is an ongoing debate whether the syntactic surface structure determines scope relations in doubly quantified sentences. A strong claim has been made that scope is the c-command domain of the QP, i.e. the quantifier that c-commands the other one in the surface structure takes wide scope over the c-commanded one (cf. Reinhart 1979, 1983, for Hungarian: É. Kiss 2002).[1]

Not only word order and surface structure but also grammatical/thematic roles may affect scope relations (Ioup 1975, Filik et al. 2004; these factors are typically intertwined with structural c-command relations). Subjects take wide scope more readily than indirect objects, while direct objects are at the bottom of this hierarchy (for Hungarian experimental data, see Gyuris and Jackson 2018). As for thematic roles, quantified agent phrases take wide scope over QPs assigned with theme role. Animacy also plays a role in affecting scope interpretation; animate QPs scope over inanimate counterparts more easily.

The lexical semantic type of the QPs affects their scope taking behavior (Ioup 1975, Liu 1990, Beghelli and Stowell 1997). It is encoded in the lexicon which quantifiers can take distributive or existential wide scope. The thesis deals with distributive scope that determines the hierarchy of quantifiers given in (2).

[1] However, more recent studies provide counterexamples and argue that c-command *per se* does not play a role in scope calculation (cf. Sportiche 2005; Barker and Shan 2008).

DOI: 10.15774/PPKE.BTK.2020.021

(2) distributive scope: each > every > all > most > many > several > a few

While *each* can take distributive wide scope easily (cf. example (1)), the quantifier *few* cannot take inverse scope over another QP.

Extra-linguistic factors also affect scope interpretation of doubly quantified sentences. For instance, world knowledge overrides other grammatical preferences of scope relation. Examples such as (3) show that the otherwise not preferred inverse scope reading turns out to be the only plausible interpretation of the sentence in certain cases. In (3), the linear scope reading would describe a specific doctor (e.g. Dr. Smith) who lives in each village of an area. It is clear that only the inverse scope interpretation makes sense, since it entails that a different doctor lives in every village:

(3) [$_{QP1}$ A doctor] lives in [$_{QP2}$ every village].

a. 'There is a doctor such that he lives in every village' #linear scope reading

b. 'Every village is such that a doctor lives in it' ^{OK}inverse scope reading

At first glance, prosody may also distinguish between two readings of a scope-ambiguous sentence. In a series of studies, Hunyadi argues that scope relations can be "read off" from the prosodic structure of the Hungarian sentence. In his framework prosodic prominence indicates the scope relations of the sentences containing more than one scope bearing element, namely the prosodically prominent operator takes wide scope over the less prominent one – this phenomenon is illustrated in (4).[2]

(4) *JÁNOS látott mindenkit.*
John.NOM saw everyone.ACC
'It was John that, for every x, x=person, saw x.'
(Hunyadi 2002: 84; ex: 60)

In (4) the pre-verbal focus takes the post-verbal universal quantifier into its scope. In the prosodic structure, the whole sentence forms one Intonational Phrase (IP) headed by the pre-

[2] I take the original capitalization, glosses and paraphrases from Hunyadi (2002). Capitalization indicates prosodic prominence.

DOI: 10.15774/PPKE.BTK.2020.021

verbal, focal subject. This is the linear scope reading of the sentence in which case the phonological linearization, the syntactic relations and the scope relations are isomorphic. However, in the case of a prosodically prominent universal quantifier, the inverse scope reading is also available for the same linearization, as it is illustrated in (5).[3]

(5) *JÁNOS látott MINDENKIT.*
John.NOM saw everyone.ACC
'For every x, x=person, it was John that saw x.'
(Hunyadi 2002: 84; ex: 61)

Hunyadi argues that there are two intonational phrases in (5): the first IP is headed by the pre-verbal focal subject and contains the verb as well, while the second IP has the post-verbal universal quantifier as its head. This is the first condition of taking inverse wide scope in a Hungarian sentence according to Hunyadi. Beside the two IPs, Hunyadi proposes an Operator Hierarchy which determines the wide scope bearing element in a case of two intonational phrases. Since the universal quantifier is higher in this hierarchy, it takes scope over the pre-verbal subject; this fulfills the second condition of inverse scope taking.

This approach takes the correlation between the prosodic difference and the scope difference at face value and posits that it is the prosodic difference that directly underlies the scopal distinction. We may call this the Prosodic Approach. This view would challenge the classic (inverted) Y-model architecture of the grammar (Chomsky 1981), in which the three modules of the grammar have restricted relations: syntactic structure is interpreted separately by the phonological module (phonological realization) and by the semantic module (logical/semantic interpretation), while the latter two have no direct interaction as Figure 1 shows with the firm lines.

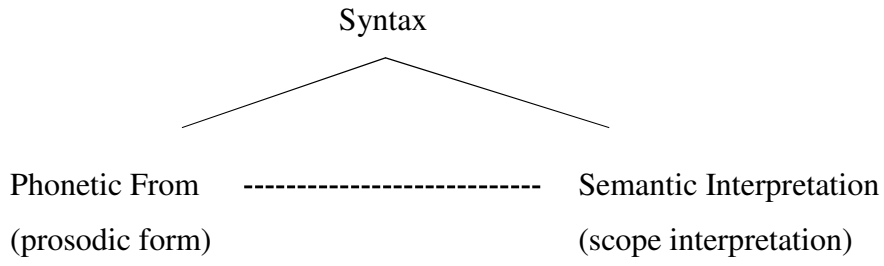

Figure 1. The classic Y-model of the grammar and the Prosodic Approach

[3]At this point I put the issue of the syntactic structure aside.

DOI: 10.15774/PPKE.BTK.2020.021

The Prosodic Approach presupposes that phonological and logical modules are connected, as it is indicated by the dashed line in Figure 1. To be more concrete, the prosodic form of the sentence can determine its scope relations (see the brackets in Figure 1), as it was demonstrated in Hunyadi's framework above.

Hunyadi also integrates into his theory the observation that the formation of intonational phrases depends on pragmatic information. The special information structural status of a contrastive topic affects the IP structure of the sentence and hence the scopal relations as well. In example (6), Hunyadi suggests that the universal quantifier functioning as a contrastive topic has an "incomplete tonal contour" and needs the tonal contour of the following phrase to make it prosodically complete (Hunyadi 2002: 117). He takes this to be evidence that the universal quantifier and negation are contained in the same IP. Since it is the negative particle that is prosodically more prominent, it scopes over the universal quantifier, which results in the only available inverse scope reading of the sentence:

(6) *Mindenkit* *NEM* *látott* *János*.
everyone.ACC not saw John.NOM

(Hunyadi 2002: 114; ex: 92)

a. 'For everyone it is true that John did not see him/her.' #linear scope reading
b. 'It is not true that John saw everyone' OKinverse scope reading

A very similar phenomenon can be observed in German. While in Hungarian a neutral intonation, licensing linear scope, is unavailable, in German both the neutral and the contrastive, special intonation result in a well-formed utterance. A well-studied example presented in (7) demonstrates that similar to the case in (6), the special intonation, the so-called rise–fall intonation (aka. hat contour, indicating contrastive topic interpretation), is associated with the inverse scope interpretation.

DOI: 10.15774/PPKE.BTK.2020.021

(7) / [QP *Alle politiker*] *sind*\ [NEG *nicht*] *korrupt*.
all politicians are not corrupt

neutral intonation: linear scope

a. ‘all politicians are such that they are not corrupt’

hat contour: inverse scope

b. ‘it is not true that all politicians are corrupt’

(Büring 2014; ex: 21)

This special intonation seems to be connected to inverse scope not only in negative sentences but in doubly quantified sentences as well. Again, in the German example presented in (8), neutral intonation of the sentence realizes the linear scope interpretation, namely that there is at least one specific student (e.g. Anna) who read every novel, while the rise–fall intonation of the subject quantifier expresses the inverse scope reading, namely that every given novel was read by at least one of the students in the class (e.g. War and Peace was read by Anna; Wuthering Heights was read by Ben and so on and so forth).

(8) [QP1 *Mindestens* / *ein Student*] *hat* \ [QP2 *jeden Roman*] *gelesen*.
at.least one student have every novel read

a. ‘There is at least one student such that he/she read every novel’ linear scope
b. ‘Every novel is such that it was read by at least one student.’ inverse scope

(Krifka 1998: 80; ex: 16b)

Based on the observations presented in (4–8), prosody seems to distinguish both between the two scope interpretations of doubly quantified sentences and also between the readings of negative quantified sentences. One could assume that it is the two prosodic forms themselves that disambiguate between the two possible scope-readings in such sentences, without a syntactic difference underlying the two readings.

The case of (4–8) illustrates the core theoretical questions this thesis is concerned with. There are at least two conceivable approaches to the facts exemplified by these examples. The first, the Prosodic Approach has already been mentioned in the description of the Hungarian example (4–5). The Prosodic Approach may cover the Hungarian example (6) and the German sentences (7–8) as well, since it associates the marked prosodic realization with the inverse scope reading.

DOI: 10.15774/PPKE.BTK.2020.021

A second possible approach may be called Information Structural Approach. This approach proposes that information structural roles have a direct effect on scope interpretation. In the Hungarian and German examples, it is clear that the information structural status of the subject is different in the two scope readings: "hat contour" marks the contrastive topic. In Büring's (2014) theory, sentences with contrastive topics are partial answers to the so-called question under discussion (QUD). These partial answers give an answer only to some sub-questions that together make up the QUD. In (7), the QUD is something like, "How many politicians are corrupt?" and the sub-questions are alternative questions which differ only in the constituent marked as contrastive topic, e.g. Are all politicians corrupt?; Are most politicians corrupt? Example (7) answers the first of these in the negative: It is not true that all politicians are corrupt. As the universal is part of the proposition, it follows that negation will scope over the universal quantifier in (7). This is the way inverse scope in (7) is related to the information structure of the sentence (for Hungarian quantificational contrastive topics and their scope, see Gyuris 2002). The Information Structural Approach considers that in this case it is not prosody that disambiguates scope but information structure has its own share in this process, since the hat-contour and contrastive topic interpretation go hand in hand. It is commonly assumed that narrow quantifier scope is linked directly to the contrastive topic status of the sentence-initial QP in such cases and the special prosody only reflects this special information structure.

Since it is highly relevant to the main issue of the thesis, at this point I complement the Y-model with Information Structure. Information Structure includes non-truth-functional aspects of sentence meaning pertaining to the relation between the sentence and its discourse context, described through notions such as focus, givenness, topic, contrast etc. Information Structure itself is not truth-functional, and it is autonomous from semantics. This is not to deny that semantic operations (such as semantic identification, exclusion) may be sensitive to it; therefore, Information Structure (IS) may have indirect semantic effects. This modified model belongs to the Information Structural Approach, based on the classic Y model which takes the interpretative modules separate and takes IS to be directly encoded within syntax, e.g. via information structural formal features, like the [focus]-feature, as in Jackendoff (1972). In this type of model, the generalization according to which the information structural role of focus is associated with prosodic prominence in PF is captured by positing a formal syntactic [focus] feature, which is mapped to the focus role in IS on the one hand, and it is mapped to prosodic prominence in PF on the other. It is syntax (including formal [focus]-features) that mediates between IS and PF. Although the hypothesis of formal IS-features has recently been challenged by what are called "interface approaches" to IS, which argue that formal IS-features are

DOI: 10.15774/PPKE.BTK.2020.021

problematic (Zubizarreta 1998, Szendrői 2003, Fanselow 2007), and a direct IS–PF interface should be assumed instead, in this dissertation I put this debate aside and follow the classic approach, since the issue of IS-features is not relevant in the cases I investigate and analyse here.

The Information Structural Approach suggests that prosody reflects only the information structure, and it is the latter one that disambiguates between the scope readings — see Figure 2. If so, no direct link needs to be posited between prosody and scope.

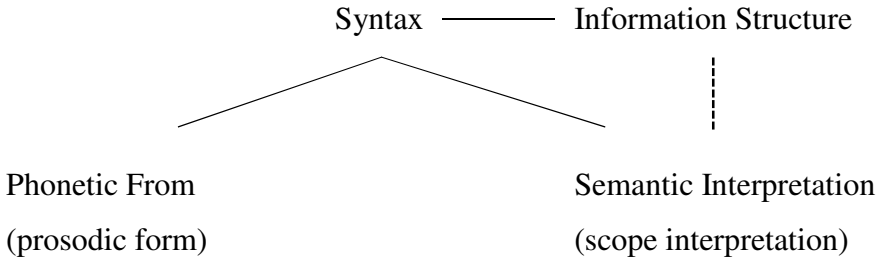

Figure 2. The classic Y-model of the grammar and the Information Structural Approach

In a broader theoretical view, not only contrastive topics, but further information structural notions such as common ground, topic–comment, focus–background, given–new, may all have an effect on scope (Ioup 1975, Erteschik-Shir 1997, Portner and Yabushita 2001, Krifka 2001; for Hungarian see Gyuris 2006, 2008), any analysis that links information structure (including IS-features represented in the syntax) without also positing a concomitant syntactic – structural – effect is categorized as belonging to the Information Structural Approach.

To illustrate this definition, let me consider the aboutness topic IS status. The informational structural status of aboutness topic is linked to wide scope interpretation, namely non-contrastive, so-called aboutness topics scope over the comment part of the sentence (Ioup 1975, Kuno 1982, 1991, Kempson and Cormack 1981, Reinhart 1983, May 1985, Cresti 1995, Erteschik-Shir 1997, Portner and Yabushita 2001, Krifka 2001, Ebert and Endriss 2004). For instance, in Turkish (9), indefinite objects lack the accusative marker, while specific or definite objects bear it. If the accusative marker is presented on the definite object, then it may function as the topic of the sentence. When functions as the topic, it takes wide scope independently whether the word order is basic (SOV in the case of Turkish) or scrambled (OSV). When the accusative object is *in situ*, both the S>O and the O>S scope readings are available. When the object is scrambled, only an O>S interpretation is licensed. One realization of this pattern is to say that in the OSV order (but in the SOV order) such objects can only function as topics, and

DOI: 10.15774/PPKE.BTK.2020.021

topics must be interpreted with wide scope. This would fall within what I call the Information Structural Approach to scope.

(9) [$_{QP1}$ *Belli bir atlet-i*]$_i$ [$_{QP2}$ *her antrenör*] ___$_i$ *çalis-tır-acak.*
certain one athlete-ACC every trainer work-CAUS-FUT
'Every trainer will train a certain athlete.'
a. 'There is a certain athlete such that he is trained by all trainers.'
b. *'Every trainer is such that he trains a different athlete.'
(von Heusinger and Kornfilt 2005: 23; ex:40)

a. Linear scope: QP1 OBJ: wide scope
QP2 SUBJ: narrow scope

b. *Inverse scope: QP1 OBJ: narrow scope
QP2 SUBJ: wide scope

An alternative formulated in the Syntactic Approach would be to say that the OSV order corresponds only to an O>S reading because in this case the object c-commands the subject in the syntax. On this approach, the O>S reading of the SOV sentence may be derived by assuming that the topic status causes an existential quantifier to be inserted in the syntax above the subject which binds the topical NP *in situ.*

Adopting what may be called a Syntactic Approach, one may suggest a similar possibility for the analysis of (7) and (8). It is based on the theory that the scope of QPs is determined by their syntactic position, namely how "high" they are in the syntactic tree (in a sense to be specified in Section 3.1.1). In example (9) it is clear that the moved and marked Object c-commands the subject over which it takes — the only available wide — scope. In (7) the two available scope readings seem challenging for the Syntactic Approach. While the linear scope reading is straightforward, the derivation of inverse scope needs a more complex theoretical machinery. As the subject in (7) is higher in the surface structure than clausal negation, the subject can take logical scope over it (this corresponds to the linear scope reading (7a)). According to the Syntactic Approach, the inverse scope reading emerges from the syntactic reconstruction of the subject to a position below negation in a covert syntactic representation called Logical Form. To derive the relation between inverse scope interpretation and the hat contour in (7), one would have to assume that the reconstruction of the subject is related to its

DOI: 10.15774/PPKE.BTK.2020.021

contrastive topic interpretation. This way, the Syntactic Approach is potentially able to explain the link between prosodic form and logical scope in examples like (7) and (8). Basically, the Syntactic Approach assumes two different unambiguous underlying syntactic structures of the two different scope readings. In this case, the core concept of the classic Y model (Figure 3.) can be maintained, as syntax is the sole interface between the other modules of the grammar.

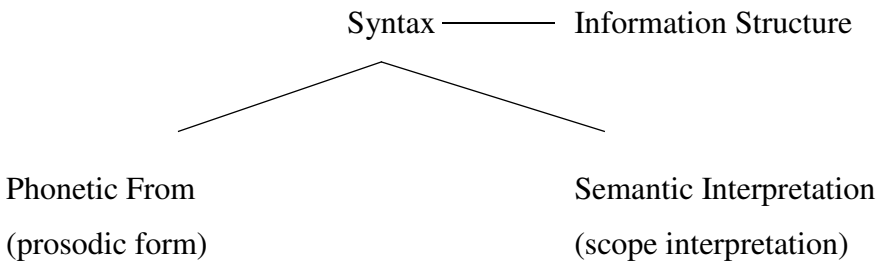

Figure 3. The classic Y-model of the grammar (and the Syntactic Approach)

The syntactic module is clearly associated with the semantic module of the grammar (cf. the principle of compositionality): this is a shared assumption of each of the approaches reviewed here. The way the Prosodic Approach and the IS Approach differ concerns what additional interface they postulate: one between PF and semantic interpretation, and one between IS and semantic interpretation, respectively. As a consequence, these two approaches have greater descriptive power, since in principle they can explain the relevant phenomena via two interfaces: the syntax-semantics interface and the additional interface they posit. That is why the Syntactic Approach (the Y-model) is the null hypothesis, and the other two come into question only if the phenomena in the experimental data cannot be derived purely in the syntax or the phenomena cannot be described in a principled manner.

This thesis is concerned with investigating these theoretical possibilities with experimental methods in Hungarian, in cases which are less transparent because they do not involve a contrastive topic. The target sentences — which are sampled in (10) — have a pre-verbal quantifier constructed with the distributive particle *is* (‘too, also’) and a post-verbal distributive universal quantifier, *mindegyik* (‘each’).

(10) *Négy előadó is el-énekelte mindegyik melódiát.*
four singer DIST.PRT VM-sang each melody.ACC
‘Four singers sang each melody.’

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a. ‘There were four singers each of whom sang each melody’ Linear: four > each
b. ‘Each melody is such that each of four singers sang it’ Inverse: each > four

The rest of this chapter is structured as follows. Section 1.2 is devoted to the specific research questions scrutinized in this thesis, while Section 1.3 shortly enumerates the various experiments and their main findings. Lastly, Section 1.4 presents the outline of the thesis.

1.2 Research questions

The foregoing discussion leads to the following general research question. The main empirical research question, RQ.i, is the following:

(RQ) i. Does prosody affect the availability of linear and inverse scope interpretations in doubly quantified sentences?

If the answer to (RQ.i) is positive, the second issue to deal with can be formulated as below:

ii. Does IS mediate between prosodic realization and scope interpretation?

In other words, the prosodic differences only reflect an information structural difference and in this case it is not prosody that determines the scope readings directly. Instead, the different readings and the different prosodic realizations are determined by information structure. If the answer to (RQ.ii) is positive, then a last, theoretical question to raise is:

iii. Is there a syntactic distinction that underlies any IS difference that is responsible for any detected scopal effects?

If so, there is no need for the revision of the extended Y-model in which syntax is the only interface between the prosodic form and the scope interpretation.

To address **(RQ)**, the specific methods and experimental questions (**EQ**) were formulated as follows. In experiments that are designed on the basis of the method that I will refer to as (method) **Type I,** the effect of prosody is investigated independently of context (i.e. out of any written context, providing only figures or only paraphrases depicting the possible scope readings), focusing solely on the role of prosody in speech production – in syntactically

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controlled sentences (i.e. the word order was invariable through the conditions). The question addressed when using method Type I is as follows:

(**EQ**) i. Can prosody disambiguate between linear and inverse scope readings in the absence of context in speech production?

Further experiments rely on what will be referred to as method **Type II**. In these experimental designs, the role of information structure is taken into consideration in a well-controlled manner. In these designs not only the scope-reading of the quantifiers were controlled by means of visual stimuli, but the target sentences were also inserted in an appropriately controlled written dialogue context. Since in experiments of Type I the context was not provided, this method minimizes the effect of contextual confounds. However, it probably has the disadvantage that the participants could associate with target sentences any (different) proper information structures, which could bias the scope readings of the sentences. Using method Type II makes sure that the experimental subjects assign a specific information structure to each sentence. With this method, both scope readings can be investigated in identical information structures, thus the results can tease apart the effect of the information structural roles (i.e. focus and given roles in these experiments) on the scope reading of the sentences. The specific experimental questions that were addressed in both speech production and perception are as follows:

(**EQ**) ii. a. Can two sentences that have identical information structures have different (linear or inverse) scope interpretations, and

b. if so, is this reflected in sentence prosody?

There are two sub-parts of experimental question (EQ.ii). If the answer is “no” for question (EQ.ii.a), then, naturally, (EQ.ii.b) does not arise, since it is obvious that sentences with different information structures may have different patterns of sentence prosody. A negative answer for (EQ.ii.a) would mean that the information structural role of a scope taking element has a direct effect on the scope interpretation of the sentence. In this case, it can be argued that information structure determines scope readings.

If the answer is positive for (EQ.ii.a), one can argue that the information structural roles do not have a direct effect on scope reading. In this case (EQ.ii.b) still has two possible outcomes. In the case of a negative answer for (EQ.ii.b), it can be concluded that what disambiguates

DOI: 10.15774/PPKE.BTK.2020.021

between the two scope readings is only the (covert) syntactic representation. If there is a positive outcome for (EQ.ii.b), that would mean that prosody reflects the different scope readings, either because there is a direct prosody–syntax mapping or because prosody reflects differences in syntactic structure that determine different scope relations.

To investigate the role of information structure more rigorously, question (EQ.ii.a) can be approached in a more detailed way. While the wide scope of QPs bearing a topic role seems relatively uncontroversial in the literature (see section 1.1 above), the effect of focus and given information structural roles are contended. The following two experimental questions implement question (EQ.ii.a) for focus status and for given status, respectively:

(**EQ**) iii. a. Keeping information structure constant, does a focused post-verbal quantifier permit only inverse scope or only linear scope with respect to a pre-verbal scope-taking element, or both?

b. Keeping information structure constant, does a given post-verbal quantifier that is part of the background of a focused pre-verbal scope-taking element permit only inverse scope or only linear scope with respect to it, or both?

In other words, experimental questions (EQ.i) and (EQ.ii) scrutinize the effect of prosody on scope-interpretation in a null context and in a controlled information structural context (cf. RQ.i and RQ.ii). Crucially, question (EQ.ii) and (EQ.iii) examine the effect of the focus and given information structural roles on scope taking (cf. RQ.ii).

All in all, the first two parts of the main Research Question (RQ.i and RQ.ii) are targeted at the Prosodic and Information Structural Approaches, which can be teased apart with experimental questions given in (EQ.i–iii.). The third part of the main Research Question (RQ.iii) is more theoretical in nature and targets the theoretical modeling of the results found in the empirical investigations.

1.3 A preview of methods and results

As mentioned above, the formulated questions were experimentally tested. Experimental question (EQ.i) was investigated in speech production. Experiment 1 involves doubly quantified sentences, Experiment 2 tests negative sentences which contain a bare numeral NP (*four printers*). Experiment 3A scrutinizes the scope relations of negative sentences which

DOI: 10.15774/PPKE.BTK.2020.021

involve a quantified NP (*more than three printers*), while the supplementary Experiment 3B checks to what extent the paraphrases given in Experiment 3A are acceptable for native speakers on a 7-point scale. In the production studies the participants had to read out the target sentences based on a paraphrase or a visual context which displayed the possible scope readings. The recordings were analyzed for standard prosodic features of phonetic prominence, i.e. F0 maxima, F0 range, F0 slope, intensity and duration. The results of the production studies revealed no effect of prosody on scope readings in the case of doubly quantified sentences, although the information structure belonging the two scope readings was expressed in different prosodic realizations in the case of the negative sentences.

Experimental method Type II — in which the role of information structure was taken into consideration — investigated questions formulated in (EQ.ii) in speech production in Experiment 4A and in speech perception in Experiment 4B. In the production studies, not only a visual stimulus (namely, a diagram presenting one of the two scope-readings), but also an additional dialogue was displayed as a textual stimulus which kept the information structural status of the quantifiers in check. No main effect of the scope was found in speech production, while the information structure had an effect on prosodic realization. The speech perception paradigm implemented forced choice methodology. The participants listened to a native speaker uttering both possible scopal interpretations of the doubly quantified sentences. A pair of two distinct recordings was played to the experimental subjects who chose one recording out of the two taking the unambiguous visual and textual stimuli into consideration. The results of the speech perception experiment exhibit no difference between the two scopal readings of the doubly quantified sentences, suggesting that prosody alone cannot distinguish between the two available interpretations, although the effect of information structure was detected. Experimental questions given in (EQ.iii) were investigated in acceptability judgments method using a 5-point Likert scale in Experiment 5. The study revealed that the focus status of the post-verbal universal quantifier does not determine its scope taking behavior, namely, it readily takes either wide or narrow scope with regard to a non-focal distributive bare numeral.

The thesis concludes that prosody does not have a direct effect on scope interpretation, although prosody reflects information structure with prosodic cues. These findings are clearly in line with the results of Baltazani's (2002) experimental investigations which — besides prosody — consider the information structural status as a factor in scope disambiguation. Supposedly, prosody helps the listener to recover the question under discussion (QUD) if there is no explicit context available. The other main conclusion of the thesis is that the focus information structural status of an element does not determine its scope taking properties. This

DOI: 10.15774/PPKE.BTK.2020.021

finding challenges the assumption that the focused operator may take either only wide (Williams 1988; May 1988; Langacker 1991; Deguchi and Kitagawa 2002, Ishihara 2002) or narrow scope (e.g. Diesing 1992, Kitagawa 1994, Kratzer1995, Krifka 2001, Cohen and Erteschik-Shir 2002, Pafel 2006). Furthermore, the scope taking behaviour of the two types of foci (in negative sentences: information focus; in doubly quantified sentences: corrective focus, as a sub-type of contrastive focus) that are dealt with in this thesis does not support the assumption of Erteschik-Shir (1997), according to which the choice crucially depends on the contrastiveness of focus in that while non-contrastive focus is related to narrow scope, contrastive focus triggers wide scope.

Bearing these findings in mind, the overall conclusions of the thesis can be formulated as listed in (11–13).

(11) Answer to RQ.i:
Prosody does not disambiguate between different possible scopal readings of (upward monotonic distributive) quantifier phrases. When prosody appears to correlate with two different possible scopal readings of a(n upward monotonic distributive) quantifier phrase, then the prosodic distinction reflects an underlying information structural difference.

(12) Answer to RQ.ii:
The information structural focus versus given status of a scope bearing element does not determine its logical scope.

(13) Answer to RQ.iii:
The information structural difference that is found to have a direct effect on quantifier scope taking can be represented by means of structural differences. However, these differences are not located in the sentence itself but in the syntactically represented QUD that the sentence is associated with.

I argue that the relation between the QUD and scope is mediated through narrow syntax. The information structural component checks whether the sentence is congruent with the QUD. Checking congruence must include a representation of scope relations. As scope relations need to be specified as part of the QUD, the QUD can affect the scope interpretation of a sentence that is congruent with it. It is in this manner that QUD plays a role in determining possible

DOI: 10.15774/PPKE.BTK.2020.021

scope readings. Crucially, however, as spelled out in (12), it is not focus or given status itself that affects scope.

These finding above favors the classical Y model, which keeps the phonetic form and the semantic module separate, having no direct interface, and which also lacks a direct mapping between information structure and logical scope.

1.4 The outline of the thesis

The thesis is organized as follows. **Chapter 2** reviews the theoretical background on information structure, quantifiers, and prosody from a broad perspective including the Hungarian particularities. **Chapter 3** reviews previous work on prosody–scope–information structure interrelations and summarizes the main issues that arose in the literature. The chapter concludes with a formulation of the specific research questions which were experimentally studied. **Chapter 4** on the first type of experiment with null context presents research investigating the interaction of scope and prosody without specified information structure. It includes three production experiments and a supplementary study on acceptability judgment. **Chapter 5** presents the details of the five experiments in which information structure was controlled by means of explicit textual stimuli, namely embedding the target sentence into a dialogue. The first two experiments of this class inspect the effect of prosody on quantifier scope reading in context. The last three acceptability judgment experiments presented in the second main section of Chapter 5 are devoted to the effect of information structure on scope interpretation in doubly quantified sentences. **Chapter 6** is devoted to putting the obtained results into a broader theoretical perspective and provides a concise conclusion of the dissertation.

DOI: 10.15774/PPKE.BTK.2020.021

2 THEORETICAL BACKGROUND

This chapter provides a detailed overview of the basic notions which are essential to the empirical and theoretical issues investigated in this thesis. The chapter mainly focuses on the fundamentals of information structure, quantifier scope interpretation and sentence prosody. The first half of each section presents a general overview, while the second half surveys the relevant properties of Hungarian.

Section 1 is concerned with information structure. It overviews the concept of information packaging and management in the discourse and the pairs of notions givenness–newness, topic–comment and focus–background. **Section 2** deals with the different kinds of quantifiers and their two types of scope-taking behavior, namely existential and distributive scope. In the dissertation, it is distributive quantifier scope that is the prime concern of investigation. **Section 3** is about sentence prosody. After laying down the fundamental notions, the section focuses on the mappings, namely, how the syntax–prosody and the information structure–prosody mapping work.

2.1 Information structure

Using sentences of a spoken natural language for providing information to the hearer requires not only a proper grammatical form but an organized utterance in a cooperative way. Structuring the information usually affects not only the words chosen but their (i) order and (ii) intonation which indicates the "different kinds of information blocks" (Chafe 1976). Such structuring is a dynamic process which develops and changes throughout the discussion, reflecting extra-linguistic aspects rooting in psychological perception (Fodor 1983). Hence information structural statuses are temporary, indicating which pieces of information are part of, or should be part of, the shared knowledge of the speakers. The mutually shared information is also called the common ground (CG, Stalnaker 1974), denoting the sum of information about the world and the information which is relevant to the particular discussion in which the speaker and hearer interact. Some information is known to be mutually shared (and in this sense, given), while other information is new; information can be modified, highlighted or backgrounded. Hence the common ground is continuously and dynamically changing during the interaction (Krifka 2008).

DOI: 10.15774/PPKE.BTK.2020.021

The truth-conditional propositional, semantic content of utterances (including profferred content, as well as presuppositions) contributes to common ground content. Pure information structural meaning is often categorized as part of the pragmatic meaning falling under the notion of common ground *management* (Krifka 2008). Topic–comment, focus–background and givenness–newness are common ground management notions. The following sections provide a more detailed picture of the terms appearing above – teasing apart the different roles and dimensions of information structure. The main information structural functions which are of relevance to this thesis are focus and givenness. I introduce these notions in the following subsections in turn.

2.1.1 Topic and Comment

The notion of topic that this thesis draws on is often called 'sentence topic' (as opposed to 'discourse topic'). Two types of sentence topics are distinguished: (i) ordinary or aboutness topics, and (ii) contrastive topics. The first type seems to be restricted to entities which the sentence is about (hence the notion aboutness topic; Reinhart 1982, Portner and Yabushita 1994). Krifka (2008: 265) provides the following informal definition:

> *The topic constituent identifies the entity or set of entities under which the information expressed in the comment constituent should be stored in the CG content.*

On this approach, aboutness topic is considered as a relational notion: sentence meaning is divided into a topic and a comment which gives information about that topic. It is also clear that this notion of topic falls under Chafe's pragmatic concept of information packaging.

One consequence of the entity-based approach to ordinary sentence topics is that they can only be referential, specific, hence presupposed elements. Typically, they are (singular or plural) individuals, like *the black dog* in sentence (14):

(14) [**The black dog** Topic], [I do not like Comment].

On the other hand, predicative elements (e.g. verb phrases, predicative adjective phrases) and adverb phrases, which are non-referential expressions, cannot be topicalized as an aboutness topic.

DOI: 10.15774/PPKE.BTK.2020.021

(15) a. #Very smart, I consider him to be.
b. #Completely, they destroyed the sand castle.

Quantifier phrases cannot be topicalized either, since they are not referential: they do not denote individuals, but properties of properties (for further details see Section 2.2). For instance, monotone decreasing quantifiers (eg. *few* in sentence (16)) are never topical:[4]

(16) [Few students $_{\#Topic}$] read a book.

Indefinites can be topics, at least when they are interpreted as specific. This kind of indefinites is also known as *referential indefinites*, *specific indefinites*, or *wide scope indefinites*. Endriss (2009) treats such specific indefinites as weak quantifiers (for further details see Section 2.2).

(17) [*Ein kleines Mädchen*]*, das wollte einst nach Frankreich reisen.*
a little girl pro wanted once to France travel
'Once, a little girl wanted to travel to France.'
Endriss (2009: 23)

Topics can be, but are not necessarily, realized in the sentence as grammatically marked. Marking may be carried out by morphology, syntax or prosody. A typical syntactic topic marking is leftward or rightward displacement (see Rizzi 1997). In English, DPs licensed as topics in the discourse can undergo leftward movement to the left edge of the sentence, such as in example (14). Topics may also be *in situ* (Neeleman and Koot 2016).

Besides word order, intonation plays a crucial role in marking topic constituents (e.g. Bulgarian, sentence (18); for Hungarian see É. Kiss 2002). Sentence initial topics are distinguished by a prosodic boundary that clearly splits the sentence into intonational units of topic and comment (intonational phrases are marked by Φ, for more details see Section 2.3).

[4] However, some monotone increasing quantifiers such as *all* or *every* can function as aboutness topics. In this case, according to Endriss (2009: 241), the QP's minimal witness set is interpreted as the topic.

DOI: 10.15774/PPKE.BTK.2020.021

(18) (***Krastavic-i***)Φ
cucumber-PL
(*vseki* *običa* *malk-i* *presn-i*)Φ
everyone likes small-PL fresh-PL
'As for cucumbers, everyone likes them fresh and small.'

Bulgarian
(Féry 2018)

While aboutness topics have to be referential and specific, the other main type of topics, namely contrastive topics, do not underlie such restrictions. They can be entities (19) but predicative elements as well (20), and even monotone decreasing quantifiers (21).

(19) a. Which kid ate what?
b. [Adam $_{\text{Contrastive Topic}}$] ate banana, [Bill $_{\text{Contrastive Topic}}$] ate grapes.

(20) a. Are your siblings studying medicine? Will they be doctors?
b. [Study medicine $_{\text{Contrastive Topic}}$], my brother never would.

(21) [Few students $_{\text{Contrastive Topic}}$] I don't want to teach. I want to teach many students.

Contrastive topics give a partial answer to the Question Under Discussion (henceforth: QUD), namely they answer a subquestion which can be derived from the wider question under discussion (Büring 2003). For instance, the broader question in (19) corresponds to (19a). A subquestion that the first clause of (19b) answers is "What did Adam eat?"

Contrastive topics can be marked in the syntax similarly to aboutness topics, by movement to the left periphery. They can be marked prosodically as well: for instance in English and German, the rise-fall (or "hat" or "B") intonation contour clearly indicates the contrastive topic function. Moreover, in topic marking languages (e.g. Japanese, Korean, Chinese) there are dedicated topic marking particles in the grammar. In Japanese, the particle *wa* can express a contrast like that expressed by the B contour in English (Kuroda 1992).

Whether contrastive topics fall under aboutness topics, or the two represent two distinct IS notions is subject to debate. Gyuris and É. Kiss 2003 argue for the former position. Krifka also treats contrastive topics as a subtype of aboutness topics: those that contain a focus. Others, like Büring 2016, take the two to be orthogonal notions.

DOI: 10.15774/PPKE.BTK.2020.021

2.1.2 Focus and Background

The other key notion in the field of information structure is focus. Focus indicates the presence of *alternatives* that are relevant for the interpretation of linguistic expressions (Rooth 1985, Krifka 1998). As such, focus is essentially a pragmatic notion and any semantic features that focus may have can be traced back to its pragmatic characteristics. Different pragmatic and semantic uses of focus correspond to different ways of how alternatives are exploited.

The alternatives that the focused element indicates have to fulfil some important requirements. The alternatives have to be comparable as well as contrastable to the focused element. More specifically, alternatives have to belong to the same semantic type and the same ontological sort, and are narrowly restricted by the context of the utterance (Rooth 1985, 1992).

Background complements the notion of focus, denoting the part of the sentence outside of the focus. Focus and background are thus relational notions.

2.1.2.1 *Pragmatic uses of focus*

Purely pragmatic uses of focus fall under the notion of common ground management. In such cases, the focusing of an expression does not have immediate influence on truth conditions. The failure of interpreting focus does not yield semantic anomaly, but incoherent discourse.

A key pragmatic use of focus is information focus, which is typically found in answers to wh-questions:

(22) a. What did John buy?
b. John bought [a new car $_{\text{FOCUS}}$].
c. {John bought a new car, John bought a house, John bought a hat, …}

Information focus selects an item from a set of alternatives specified by the question. The question that an information focus answers does not need to be explicit; very often it is implicit: according to Roberts (1996), a coherent discourse is structured by implicit questions, i.e. Questions Under Discussion, and information focus answers such questions. Thus, the focus in a declarative sentence indicates what the actual Question Under Discussion is that the current sentence provides an answer to (in accordance with the principle of question-answer congruence). It is important to underline that this notion of information focus is not equivalent

DOI: 10.15774/PPKE.BTK.2020.021

to newness: although it is more often than not discourse-new, the information focus, or its designated referent, may also be discourse-old.

The notion of information focus which I will adopt for the purposes of this thesis has in common with É. Kiss's (1998) information focus that it belongs to the realm of pragmatics, rather than semantics, and that it obeys the principle of question-answer congruence. It differs from it in incorporating the relevance of alternatives, following Rooth (1985) and Krifka (1998), and in not excluding certain semantic enrichments, to which I turn next.

2.1.2.2 *Semantic uses of focus*

At first glance, the distinction between pragmatic and semantic uses of focus seems categorical, however, it is more like a (super)set–subset relation: a semantic, truth-conditional use of the focused element comes as an addition to its pragmatic use. The semantic effects come from some additional element in the sentence, which operates on the alternatives introduced by the focus. Such focus operators, associated with focus, have a truth conditional effect by means of modifying the common ground content of the sentence. Hence the failure of comprehending that semantic function of the focus element causes unintended factual information in the communication (Krifka 2008).

For instance, a declarative sentence containing *only* and a focused element asserts that the sentence is exhaustive with regard to the set of alternatives introduced by the focus. To illustrate it with an example, (23) means that among the relevant individuals, there is no other individual than John who saw the film. Exclusivity is a semantic contribution of the focus operator *only*. One may also infer exclusivity in the case of ordinary information focus, such as in (23.b), but that exclusivity is due to a scalar conversational implicature, rather than part of the semantic content. Accordingly, the utterance in (23.b) can be continued by the same speaker with (23.c), cancelling exclusivity, while (23.a) cannot (É. Kiss 1998, Kratzer 2003).

(23) a. Only JOHN saw the film.
b. JOHN saw the film.
c. And MARY saw it too.

While in the case of the particle *only* exhaustivity is asserted, *it*-cleft sentences only entail the exhaustive meaning component without asserting it. That is why negating an *only*-focus negates exhaustivity but negating the focus of an *it*-cleft does not:

DOI: 10.15774/PPKE.BTK.2020.021

(24) a. It is JOHN who saw the film.
b. It is not JOHN who saw the film, but MARY.
c. Not only JOHN saw the film, but also MARY.

According to Higgins (1972), *it*-clefts express identificational predication, and their obligatory exhaustivity is due to this identificational semantics (where the identificational semantics may come from an identificationally interpreted copula, or a silent dedicated null identificational operator, like Horváth's (2007) Ei-OP).[5]

A subtype of focus that has not been discussed so far but which will play a key role in the experiments presented in this thesis is contrastive focus. By using contrastive foci, the speaker presupposes that the common ground content contains a proposition with which the current utterance can be contrasted, or that such a proposition can be accommodated. A typical use of contrastive focus is corrective focus. Corrective focus is used when the speaker explicitly rejects an alternative and corrects it with the focused element (Krifka 2008). In the context of (25.a), (25.b) corrects (25.a) by asserting that John bought pears, and it is implicated that he did not buy apples.

(25) a. John bought apples.
b. [John bought $_{\text{Background}}$] [PEARS $_{\text{CFocus}}$].

This type of focus is also known as 'counterassertive' (Dik 1980; Gussenhoven 1983). Corrective focus is the most relevant type of foci in this thesis, since the doubly quantified target sentences in the experiments that I present contain corrective foci.

Focus marking may be limited to certain pragmatic/semantic uses in a given language. In English, as well as in many other languages, focus is marked by prosodic prominence, as the focused element receives the nuclear accent of the sentence (cf. Chomsky 1971, Selkirk 1984, Reinhart 1995 among others). Nuclear accent was indicated by capitalization in the previous example sentences. Not only prosody but also syntactic structure can indicate the focused constituent by non-canonical word orders: either the focus (cf. Chomsky 1976, Krifka 2006) or

[5] É. Kiss' identificational focus is semantically exhaustive focus. In our current terms, identificational foci are always information focus, since they provide an answer to the QUD. This is in difference to É. Kiss' (1998) notion of 'information focus', where information focus is treated on a par with presentational focus, i.e. as 'new/non-presupposed information'.

DOI: 10.15774/PPKE.BTK.2020.021

the background part (cf. Neeleman and Reinhart 1998) can be displaced from their canonical position. The prosodic and syntactic marking may be interrelated: movements may serve the purpose of placing the focal constituent into a syntactic position where it gets mapped in default sentence prosody to the (default) position of the nuclear accent (cf. Reinhart 1995: stress-focus correspondence principle and cf. Neeleman and Reinhart 1998, Roberst 1998, Zubizarreta 1998, Büring 2001, Costa 2004; Szendrői 2003: *Stress-driven movement*). This can be illustrated by European Portuguese data from Costa (2004). In this language, identificational focus is marked both syntactically and prosodically. The information structurally neutral sentence structure undergoes scrambling, yielding the focused element settled at the right-most position, where it receives nuclear stress. In the case of (26) the adverb is scrambled to the end of the sentence in order to receive nuclear stress and does not let the object sit in its original position.

(26) A: *Como é que o Paulo fala francês?*
how does Paulo speak French
'How does Paulo speak French?'
B: a. *O Paulo fala francês* [*bem* Focus].
Paulo speaks French well
b. *#O Paulo fala* [*bem* Focus] *francês.*
Paulo speaks well French
'Paulo speaks French well.'

European Portuguese (Costa 2004: 176; ex: 137)

2.1.3 Givenness and Newness

Givenness is a complex notion referring to contextually familiar elements and it is scalar by nature. It can be approached in various different but overlapping ways. Givenness can be defined in terms of (cognitive) salience (Chafe 1974) in the interlocutor's minds. The leader of a world power will be more salient in such a discourse about global politics, while the saliency of a smaller leader may change from region to region. An element can be said to be given if it corresponds to a discourse referent already present in the common ground (referential givenness). Alternatively, givenness may be defined in terms of a previous presence of the denotation of a linguistic element in the textual context (i.e. denotational givenness; Ladd 1980). These latter two notions overlap, but are distinct. For instance, if someone is talking

DOI: 10.15774/PPKE.BTK.2020.021

about politics, the most popular politicians may count as referentially given, with/without a previous mention of their name or any direct reference to them,i.e. without them being denotationally given. Krifka (2016) formulates the above properties as follows:

> A feature X of an expression α is a Givenness feature iff X indicates whether the denotation of α is present in the CG or not, and/or indicates the degree to which it is present in the immediate CG.
>
> (Krifka 2016: 6)

The morphological marking of givenness can be realized by anaphoric expressions like personal pronouns, clitics, or definite articles. In (27) the textually mentioned *John* (27.a) is referred back to by the anaphoric personal pronoun *him* and the definite noun phrase *this friend of mine* in the second sentence (27.b).

(27) a. I thought about **John**$_{i}$ yesterday.
b. I decided to call [**him / this friend of mine**$_{\text{Given}}$]$_{i}$.

Additionally, the scalar nature of givenness is reflected in the way the given element is marked by syntax and/or prosody. Prosodically, newness is the unmarked, default case (Selkirk 2008).

This dissertation concentrates on the interaction of focus with scope interpretation (and prosody), however, target sentences of several of the experiments to be presented contain given elements. Those elements are either referentially given, by virtue of the referents being presented in pictures, or they are both referentially and denotationally given, by virtue of being accompanied by a context-setting question in addition to the picture.

A common prosodic marker of given elements is reduction in prosodic prominence (e.g. lower F0-maximum, slope, duration, intensity; for more details, see Section 2.3.3), which may be purely phonetic, but it may also be phonological (e.g. deaccenting). However, this latter marking is not necessary but a parametrically varying property of languages: for instance, there is no givenness-based deaccenting in Italian (cf. Ladd 1990, 2008).

Givenness is syntactically relevant. Taking word order in flexible word order languages into consideration, a well-known generalization is the Given-before-New Generalisation, already formulated in Behaghel's (1932) Second Law. For instance, Kucerová (2011) shows that in some Slavic languages (Czech, Russian, and Serbo-Croatian), in cases when word order is

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flexible, givenness is always grammatically marked by word order: referentially specific given elements precede new ones.

Turning to the relations between givenness/newness and the other information structural notions, it seems that they represent another dimension of the information structure. Although focus is often associated with newness and topicality with givenness by default, given elements can be focused and in special contexts new elements can be topicalized. Taking a closer look at the relation of focus and givenness is instructive at this point. Focus and givenness are orthogonal to each other in the case of so-called second occurrence focus (SOF, Partee 1999): an SOF element is both (denotationally and textually) given and focused. The reason why these instances are called second occurrence focus is that the SOF element, like *one* in sentence (28.b) functions as a focus in a previous sentence.

(28) a. Who ate only ONE apple?
b. [JOHN $_{\text{FOCUS}}$] ate only [**one** $_{\text{SOF}}$] apple.

As for the prosodic realization of SOF, it seems that deaccentuation of given constituents overrides focus accentuation (Partee 1999 call this "phonologically invisible focus", albeit for German data challenging phonological invisibility, see Féry and Ishihara 2005).

2.1.4 Information structure in Hungarian[6]

Hungarian has a relatively free word order compared to English. The arguments of the verb and the verb itself do not have a strict order relative to each other. All the permutations of the three syntactic elements are available and count as grammatical, although they typically have different meanings and they are licensed by different contexts. The crucial point in the interpretation is whether the arguments occupy the pre-verbal or post-verbal field. The post-verbal field is information structurally neutral domain: namely, the order of the post-verbal arguments does not yield any information structural difference. This latter fact can be observed in the case of (29.e) and (29.f), in which the native intuition does not differentiate in meaning. On the other hand, the preverbal field is an information structurally sensitive domain, it harbors topic and focus as well. The immediately preverbal position is designated to identificational

[6] Throughout this section I mainly follow É. Kiss (2002). A difference in terminology is that I adopt the definition of informational focus presented in section 2.1.2.2. In É. Kiss (1998, 2002), the term information focus refers to non-presupposed, new information, which provides an answer to an explicit or implicit question.

DOI: 10.15774/PPKE.BTK.2020.021

focus (É. Kiss 2002), while the topical elements take higher positions.[7] In Hungarian sentences, at least one of the arguments typically gets topicalized, unless the clause contains no topicalizable element.[8]

(29) a. *Péter Marit szereti.*
Peter Mary.ACC likes

b. *Marit Péter szereti.*
Mary.ACC Peter likes

c. *Péter szereti Marit.*
Peter likes Mary.ACC

d. *Marit szereti Péter.*
Mary.ACC likes Peter

e. *Szereti Péter Marit.*
likes Peter Mary.ACC

(f. *Szereti Marit Péter.*)
likes Mary.ACC Peter

'Peter likes Mary'

2.1.4.1 *Topic and Comment*

There is a designated topic position in the left-periphery of the Hungarian sentence. A test for the topic position is that it can be separated from the comment/predicate (É. Kiss 2002) by sentential adverbials, as (30) shows:

(30) [Topic *Péter*] [*általában* ADV] [Predicate *vesz egy kenyeret a boltban*].
Peter usually buy a bread.ACC the grocery.in
'Peter usually buys a loaf of bread in the grocery.'

The left periphery may host multiple topics, whose relative order is free. (30') represents multiple topics on the left of the sentential adverbial.

[7] The pre-verbal position is not only information structurally sensitive but logically as well. Logical operators which have scope (e.g. quantifiers and the negative particle) also occupy this position.

[8] Such sentences are topicless or thetic sentences: they contain non-specific, indefinite intransitive subjects, as the example below:

(i) *Befutott egy vonat.*
VM.ran a train
'A train has arrived'

DOI: 10.15774/PPKE.BTK.2020.021

(30') [$_{\text{Topic}}$ *A* *kenyeret*] [$_{\text{Topic}}$ *Péter*] *általában* [$_{\text{Predicate}}$ *a* *péknél* *veszi* *meg*].
the bread.ACC Peter usually the bakery buy VM
'Peter usually buys the bread in the bakery.'

In Hungarian, the aboutness topic does not have to be contextually given, it can be contextually new: e.g. sentence (31) containing a specific indefinite subject can be uttered out of the blue.

(31) *Egy* *járókelőt* *elütött* *egy* *autó.*
a pedestrian.ACC VM.hit a car
'A pedestrian was ran over by a car.'

Topics are usually marked not only by syntax but prosody as well. They may be prosodically separated from the comment, which has the nuclear accent of the sentence on its left edge. However, when the topic is contextually given, it can be deaccented.

Contrastive topics do not differ in their syntactic distribution from aboutness topics in Hungarian. Similarly to aboutness topics, a Hungarian sentence can contain multiple contrastive topics. Aboutness topics and contrastive topics typically differ formally only with respect to their intonational properties: while aboutness topics typically bear a falling contour, contrastive topics typically bear a non-falling contour. A characteristic contour of contrastive topics is the (falling-)rising contour (similar to the first part of the "hat" contour described in German (Büring 2014, see example (7) in Section 1.1).

Canonically, the topic position cannot host quantifiers not only because of their non-referential meaning but because monotone increasing, distributive quantifiers have their own designated position in the preverbal field (Szabolcsi 1997, É. Kiss 2002, and see Figure 1 below in Section 2.2.4.1). Nevertheless, quantifiers can function as contrastive topics (32), and in such a case it is assumed that they are in topic position as well – as it was presented in Section 1.1 above.

(32) [*Mindenki* $_{\text{CT}}$] *nem* *lehet* *olimpiai* *bajnok.*
everyone not be Olympic champion
'Not everyone can become an Olympic champion'

DOI: 10.15774/PPKE.BTK.2020.021

Indeed, the only one possible realization of (32) is if the universal quantifier subject is uttered with a marked, contrastive intonation. For more details on the inverse scope taking behaviour of the contrastive topics in sentences like the above, see Section 2.2.4 below and Gyuris (2002), and É. Kiss (2003).

2.1.4.2 Focus and Background

Hungarian identificational focus is marked syntactically as well as prosodically, as it is shown in sentence (33):

(33) [*János* Topic] [[*egy* *KÖNYVET* Focus] *vett* __ Predicate].
John a book.ACC bought
'John bought a book'

Identificational foci occupy the immediately preverbal position in the predicate domain and receive the nuclear accent of the sentence.[9] Identificational structural focus entails the exhaustive interpretation of the focal element, however, exhaustivity is not asserted (similarly to *it*-clefts in English, see Section 2.1.2.2). As mentioned in footnote 2 above, Identificational focus is taken to be a sub-case of information focus: it is interpreted in the context of relevant alternatives and it represents an answer to a QUD.

There are a number of elements which obligatorily take the structural focus position in Hungarian sentences. One group of these are phrases formed with the focus particle *csak* 'only', which explicitly asserts the exhaustive meaning.

(34) [*János* Topic] [[***csak*** *egy* *KÖNYVET* Focus] *vett* __ Predicate].
John only a book.ACC bought
'John bought only a book'

Monotone decreasing quantifiers (e.g. kevés 'few') obligatorily take the structural focus position, too:

[9] The immediately preverbal position is crucial in the case of the Hungarian. Structural focus triggers inversion of the verb and the verbal modifier (this category involves adverbials and verbal particles as well).

DOI: 10.15774/PPKE.BTK.2020.021

(35) [*János* Topic] [[***kevés*** *könyvet* Focus] *vett* __ Predicate].
John few book.ACC bought
'John bought few books.'

Post-verbal information foci are not marked syntactically in Hungarian and are not interpreted exhaustively:

(36) a. What did John buy?
b. *pro Vett* [*egy* *könyvet* Focus].
bought a book.ACC
'He bought a book.'

2.1.4.3 Givenness and Newness

Varga (1981) assumes that syntax reflects given and new information structural status in Hungarian following a prosodic observation presented in (37).

(37) a. *Mit csinált a konyhában?*
what did the kitchen.in
'What did she/he do in the kitchen?'

b. *Begyújtott a konyhában a fiának.*
VM.fire.lit the kitchen.in the son.his.for
'He lit a fire in the kitchen for his son.'

c. # *Begyújtott a fiának a konyhában.*
VM.fire.lit the son.his.for the kitchen.in
'He lit a fire for his son in the kitchen.'

Varga (1981: 200)

Varga (1981) suggests that (37.c) is an unacceptable answer to (37.a) and formulates that in the case of having a given and a new element in the post-verbal field, the (accent-bearing) new element has to be clause-final, since the given constituent has to avoid the prosodically

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prominent sentence final position.[10] This is consistent with Behaghel's Second Law, according to which given elements (in his terms *die alten Begriffe* 'old concepts') tend to be placed before new (*die neuen Begriffe*) elements.

A recent experimental study, conducted by Szalontai and Surányi (2020), used a forced choice task to explore preferred post-verbal word orders involving two constituents each of which was either given or new. They found evidence that native speakers prefer to place topical given constituents to the immediately post-verbal position, preceding contextually new items in the clause final position. However, this given-before-new word order option was found to be just a preference and not a categorical choice ruling out the other order. The authors interpret this surface word order variation in terms of prosodic structure.

2.2 Quantifier scope[11]

2.2.1 Basic notions regarding quantifiers

In logic, operators take a domain — called the *scope* of the operator — in which they have an effect. In natural language such a relation is realized syntactically as a sister relation in sentence structure (38.a). For instance, negation is a so-called unary operator, since propositional (sentential) negation (NEG) is an operator that takes the truth value of its sister proposition and yields its inverse.

(38) a. $\text{NEG}_{\text{OPERATOR}}$ [sister constituent]$_{\text{SCOPE}}$
b. John didn't [regularly attend the course]$_{\text{SCOPE}}$
c. John regularly didn't [attend the course]$_{\text{SCOPE}}$

Quantifier determiners, on the other hand, are binary logical operators. The quantifier determiner operator takes an NP — a so called restrictor — which has a variable (X). The operator (Q) and the restrictor (NP) form the quantifier phrase (QP). The scope of the operator is the sister of the whole QP. The scope of the operator Q contains the bound variable X. (35a)

[10] This implicates that post-verbal given elements must be prosodically non-prominent, i.e. deaccented. For the sake of a complete picture it is worth mentioning that besides Varga (1981, 2002), Gyuris (2012) also proposes that the deaccentuation of a postverbal given element is a general rule. However, Vogel and Kenesei (1987), Kenesei and Vogel (1989) and Kálmán and Nádasdy (1994) claim that such a postverbal deaccentuation of given elements only takes place if a preverbal narrow focus is present in the sentence.

[11] Throughout this section I mainly follow Szabolcsi 1994, 2010.

DOI: 10.15774/PPKE.BTK.2020.021

represents this structure abstractly, which is exemplified by (39b). The points in (40) summarize the relevant terminology.

(39) a. [Q*OPERATOR* [NP containing a X]RESTRICTOR] [sister containing a X]SCOPE
b. [[Every [restrictor bird]] [scope flies]].

(40) a. Binary logical operator = quantifier
b. Binary logical operator + its restrictor = quantifier phrase, QP
c. Scope of binary logical operator (called nuclear scope) = its sister.

Following standard practice, instead of saying that the quantifier *every* takes its nuclear scope constituent VP as a second argument, I will say informally that the QP *every bird* takes scope over (and binds a variable within) the VP.

Speaking in terms of denoted sets, (35.b) is true just in the case if the set of bird individuals is included in the set of flying individuals. Different quantifiers correspond to different relations between two sets of individuals (restricting attention here to first-order quantification over type *e* individuals only). Universal quantifiers correspond to set inclusion.

While determiner quantifiers, like *every*, are restricted in the sense of having a restrictor as outlined in (39–40), in natural language this semantic restriction is further restricted by discourse context. For instance, (39.b) can be false or true depending on the set of birds under discussion in the context. This contextually relevant set may include just prototypical birds, or all birds, or birds kept in a particular zoo.

2.2.2 Scope and quantifier types

2.2.2.1 *Quantifier scope is always distributive*

The notion of distributive interpretation is illustrated by the example below:

(41) Every child ate a pizza.
'Every child is such that he/she ate a pizza'

No collective reading is available for (41), only a distributive reading, on which the predicate *ate a pizza* is applied to each member of the contextually relevant set of children. Viewed from

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the perspective of the indefinite within that predicate, there is a referential dependency between the interpretation for the quantifier and that of the indefinite: in the course of the verification of the truth of the sentence, the reference of the indefinite *a pizza* potentially co-varies with members of the relevant set of children (i.e. there is a different pizza for each child). In the case of (41) with the consumption verb *eat*, these pizzas must be distinct (each child cannot have eaten the same pizza), but in the case of a verb like *saw* the reference of these pizzas may or may not coincide: each child may have seen the same pizza (or different pizzas). In the case of the situation in which every child saw the same pizza, the distributive surface scope is logically equivalent to the inverse scope interpretation, on which there is a (specific) pizza that every child saw. Thus, only the reading with co-variation between the universal and the indefinite unambiguously represents distributive surface scope.

2.2.2.2 *Scope interaction in doubly quantified sentences*

The referential dependency between two QPs of a doubly quantified sentence may be "direct" or "inverse", with both of these readings representing distributive scope. Recall sentence (1) appearing at the very beginning of the thesis, repeated in example (42).

(42) [$_{QP1}$ Exactly two students] did [$_{QP2}$ each assignment].
   a. 'Exactly two students are such that they did each assignment.'
   b. 'Each assignment is such that it was done by exactly two students.'

(42.a) is the linear interpretation of this scope-ambiguous sentence, since QP1 takes wide scope over QP2, which has narrow scope. On this reading, each of two students is mapped to every assignment. Figure 4 depicts such a scenario.

	assignment week 1	assignment week 1
	assignment week 2	assignment week 2
Anna	Ben	
	assignment week 3	assignment week 3
	assignment week 4	assignment week 4

DOI: 10.15774/PPKE.BTK.2020.021

	~~assignment week~~ 1	assignment week 1
	assignment week 2	~~assignment week 2~~
Cecilia	Daniel	
	~~assignment week 3~~	~~assignment week 3~~
	assignment week 4	assignment week 4

Figure 4. The linear scope interpretation of (42)

On the other hand, (42.b) is the inverse reading of the doubly-quantified sentence. In this case QP1 is in the domain of QP2: the latter takes wide scope over the former. The scope interpretation is not isomorphic to the word order (surface structure) of the sentence. Figure 5 illustrates that reading, on which each assignment is mapped to (different) sets of two students.

	~~Anna~~		Anna
	Ben		~~Ben~~
assignment week 1		assignment week 2	
	Cecilia		Cecilia
	~~Daniel~~		~~Daniel~~
	~~Anna~~		Anna
	Ben		~~Ben~~
assignment week 3		assignment week 4	
	~~Cecilia~~		~~Cecilia~~
	Daniel		Daniel

Figure 5. The inverse scope interpretation of (40)

According to the theory of Quantifier Raising (May 1985), a QP commands (c-commands, or in some implementations, m-commands) its scope at the relevant level of syntactic representation, which is Logical Form (LF). LF is obtained from surface structure by applying syntactic transformations, including the covert movement of QPs. For instance, the inverse scope of example (42) is assumed to have the covert syntactic structure along the lines of (42').

(42') [**each assignment**$_i$ [exactly two students did ___$_i$]] (LF of ex. (42))

DOI: 10.15774/PPKE.BTK.2020.021

It holds of (42') that the universal QP takes its scope as its sister constituent, thereby representing the inverse scope reading of example (42). The movement to the scope position is not invariably equated with the special operation of QR, and further, this movement may also take place in overt syntax. I will have more to say about this in the next subsection on Hungarian.

As noted at the end of the previous subsection, in some examples a subcase of the surface scope reading is equivalent to the inverse scope reading. In such cases the surface and inverse scope readings are in a logical entailment relation: the former is logically stronger than the latter. For instance the surface scope reading of (43) formulated in (43.a) logically entails the inverse scope reading or the sentence, given in (43.b).

(43) A boy loves each girl.
   a. There is a specific boy(=Bill) such that he loves each girl. →
   b. For each girl there is a boy(=Bill) who loves him.

If there is a specific (boy, Bill) such that he loves each girl (43.a=surface scope), then for each girl there is a boy who loves her (43.b=inverse scope; namely, Bill). By comparison, the inverse scope reading of (43) does not logically entail the surface scope reading. This is because if for each girl there is a different boy who loves her (43.b=inverse scope), then it is not necessarily the case that there is a specific boy who loves each girl (43.a=surface scope).

As we saw above in the case of example (1=42), a narrow surface scope interpretation of a universal quantifier does not always entail its wide inverse scope interpretation. Another type of scenario in which this is the case (and one that will figure prominently in several experiments in the present thesis) is depicted below:

DOI: 10.15774/PPKE.BTK.2020.021

History Student	History assignment1
	History assignment2
	History assignment3
	History assignment4
Literature student	Literature assignment1
	Literature assignment2
	Literature assignment3
	Literature assignment4
Math student	Math assignment1
	~~Math assignment2~~
	Math assignment3
	~~Math assignment4~~

Figure 6. Another scenario verifying the linear scope interpretation of (42)

This scenario is minimally different from the one depicted in Figure 4. Here the sets of homework assignments co-vary with the students (history student – history assignments; literature student – literature assignments; math student – math assignments), and it holds for exactly two students (namely the history student and the literature student, since the math student failed his second and fourth assignment) that they did each (of their) assignments. In particular, in this type of scenario it is the contextual restriction associated with the universal quantifier phrase that co-varies with each student: for each student there is a different set of assignments over which the universal quantifier quantifies. In this scenario the surface scope reading of the sentence above is true, but the inverse scope reading is false.

Not only the scope of two quantifiers can interact, causing ambiguity in a sentence. In addition to e.g. adverbials and numerals, the scope of the negative particle can be interpreted inside or outside the scope of a distributive quantifier. This thesis will also examine the relative scope readings of the negative operator and a quantified NP in quantified sentences — such as the one given in (44) — as well.

DOI: 10.15774/PPKE.BTK.2020.021

(44) [$_{QP}$ Every printer] did [$_{NEG}$ not] break down.

a. ‘Every printer is such that it did not break down.’

Linear scope:	QP	every:	wide scope
	NEG	not:	narrow scope

b. ‘It is not true that every printer broke down’.

Inverse scope:	QP	every:	narrow scope
	NEG	not:	wide scope

The linear interpretation of (44) is paraphrased in (44.a), which depicts a situation in which every printer remained intact, for instance, after an electrical blackout. The QP has wide scope over the negative particle, i.e. the particle has narrow scope. On the other hand, (44.b) describes a situation in which the blackout damaged some of the printers but not all of them. This is the inverse scope reading of the sentence, since the negative operator negates the proposition that contains the QP; in other words, negation has wide scope.

2.2.3 Quantifiers vs. indefinites, distributive vs. existential scope

NPs formed by genuine quantifiers are special in that they do not denote singular or plural individuals (or groups) or properties. According to the theory of generalized quantifiers (GQ) (Barwise and Cowper 1981), they denote a set of properties. For instance, *every student* denotes the set of properties that every student has. The expression *at least three students* denotes the set of properties that at least three students have. Although GQ theory can treat any noun phrase with a determiner or numeral as a GQP, empirically, not all occurrences of such NPs are in fact genuine GQPs (Szabolcsi 2010). Genuine quantificational NPs undergo (overt or covert) movement to their scope position, as noted in the previous subsection. A widely assumed restriction on this movement is that it must be finite clause bound. For instance, the QP that appears in the embedded finite clause in the example below cannot scope over the indefinite in the matrix clause:

(45) A teacher said that you met every student.

Many occurrences of existential indefinites do not behave like genuine quantifier phrases. One notable difference is that the existential scope of indefinites can extend beyond the

DOI: 10.15774/PPKE.BTK.2020.021

immediately containing finite clause (45.a), and it can even cross strong island boundaries (45.b), i.e. syntactic boundaries of constituents that cannot generally be crossed by movement operations.

(45) a. finite clause:
I believe that you met three relatives of mine.
'There are three relatives of mine such that I believe that you have met them.'
b. strong island:
If three relative relatives of mine die, I will inherit a fortune.
'There are three relatives of mine such that if they all die, I will inherit a fortune.'

This has been taken as evidence that the scope of existential indefinites is not derived by a movement operation like QR, but through some other, non-local mechanism, such as binding. One popular mechanism is the generation of an existential quantifier over choice functions in the scope position. (45.b) would be rendered as (46), where **f** is a function that selects three relatives from the set of my relatives (Reinhart 1976).

(46) [Exist f [I will inherit a fortune if f(three relatives of mine) die]]

Unlike the scope of genuine quantifiers like *every*, the non-local existential scope of indefinites is not distributive. In (47), the existential scope of the plural indefinite extends over the matrix clause. The reading is paraphrased in (47.a). While existential scope is matrix scope, this cannot be interpreted distributively there, see (47.b).

(47) Some directors believe that two actresses read a play.
a. 'There is a set of two actresses such that there is some director
who believes that each one of those actresses read a play'
b. #'There is a set of two actresses such that for each of them
there is a different director who believes that she read a play.'

One possible view is that while quantifier phrases like *every boy* and *most boys* are unambiguously quantificational expressions (and they mandatorily have distributive scope), existential indefinites have two interpretations: (i) a quantificational interpretation, on which they are existential quantifiers with local distributive scope, and (ii) a non-quantificational

DOI: 10.15774/PPKE.BTK.2020.021

interpretation, on which they introduce a descriptive nominal restriction, while the existential quantificational force comes from an independent source, which may be non-local, such as binding by an existentially quantified choice function variable (Winter 2000). A case of local inverse distributive scope of an indefinite NP is illustrated below:

(48) Some guards are standing in front of three of the buildings.
'There are at least three buildings such that in front of each of them there are some guards standing.'

Szabolcsi (1997) argues that beyond universal QPs like *each N* and *every N*, proportional QPs like *most N*, as well as monotone increasing indefinites like *at least three N* are genuine quantifier phrases[12], and as such, they must be interpreted distributively. Quantified indefinites (indefinites introduced by a determiner or numeral) with purely intersective determiners/numerals, like *an N, some N* and *three N,* are not taken to be genuinely quantificational (Szabolcsi 1997 uses Partee's 1987 term 'essentially quantificational'). Numeral indefinites like *many N* and *more than three N* are taken to be ambiguous between an ordinary quantifier phrase interpretation and another quantificational interpretation that she calls 'counting quantifier' interpretation. Counting quantifiers "specify the size of a participant of the atomic or plural event described by the verbal predicate in conjunction with the counting quantifier's restriction." (Szabolcsi 2010: 173). The interpretation of *many N* as an ordinary quantifier phrase is what is also called its proportional reading, roughly meaning 'more than half of N'. The counting interpretation of *many N* is a pure cardinal reading: the numerosity of N is high on some contextually determined scale, independently of the proportion this represents. The ordinary quantifier phrase interpretation of *more than three* N is a presuppositional, partitive-like interpretation, while the counting interpretation is again a cardinal interpretation. Szabolcsi (2010: 174) illustrates the difference between the ordinary, distributive quantificational interpretation and the counting interpretation, with the following pair of paraphrases in the case of an example like (49).

[12] Szabolcsi (1997) does not interpret these QPs as sets of properties. Rather, she takes them to introduce a referent, functioning as a logical subject, that is distributed over.

DOI: 10.15774/PPKE.BTK.2020.021

(49) More than six children lifted up the table.

a. ‘There is a set of more than six children such that each element of this set lifted up the table.’

b. ‘Greater than six is the number n such that there was an event of table-lifting by children whose collective agent, or the individual agents of its subevents, numbered n.’

(Szabolcsi 2010: 174; ex: 42, 43)

2.2.4 Quantification in Hungarian[13]

Quantifier phrases in Hungarian can be situated either post-verbally or pre-verbally. Since the word order of the post-verbal field is generally flexible, the surface position of post-verbal QPs is also free. Pre-verbal occurrences of QPs can appear in three types of positions, as first described in detail by Szabolcsi (1997). Two of these are the topic position and the focus position. The topic position can house definites, including *a legtöbb fiú* ‘lit. the most boy’, and specifically interpreted positive existential indefinites like *egy fiú* ‘lit. a boy’, *két fiú* ‘lit. two boy’, and also *sok fiú* ‘lit. many boy’ and *legalább két fiú* ‘lit. at.least two boy’. Counting QPs like *kevés fiú* ‘lit. few boy’ must occur in the immediately pre-verbal focus position. The focus position can also host positive existential indefinites. While the quantifier *most* is inherently distributive, the existential indefinites can apply to both distributive and collective predicates. I turn to the third type of pre-verbal position next, and will return to the post-verbal field in the subsequent subsection.

2.2.4.1 *Pre-verbal Quantifier Position*

Syntactic tests provide striking evidence of a third, designated position for monotonically increasing, obligatorily distributive quantifier phrases, like universal QPs, in the Hungarian pre-verbal field. These inherently distributive quantifiers beginning with the stem *mind-* (*mindenki* ‘everyone’, *minden* ‘every’, *mindenhol* ‘everywhere’ etc.) show a special syntactic distribution different from focus and topic. This designated syntactic position is analyzed by Szabolcsi

[13] Throughout this section I mainly follow É. Kiss (2002) and Szabolcsi (1997, 2010).

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(1997) as the specifier of a Dist(ributive)P, a dedicated syntactic projection. For the purposes of this thesis it is immaterial whether this syntactic position in the clause is analyzed as involving substitution in the specifier of a functional projection, as in Szabolcsi (1997) and É. Kiss (2002), or it involves adjunction, as maintained by É. Kiss (1994, 2010) and Surányi (2002). What is important is that QPs that are raised to occupy this position must take surface scope (Hunyadi 1986, É. Kiss 1987, 1991).

The position under discussion (labeled as DIST in the examples below) is initial in the predicate phrase of the Hungarian sentence, and can only be preceded by certain adverbials. It precedes the focus position and follows syntactic topics. This position can be occupied by positive existential indefinites introduced by 'many' or by a modified numeral like 'at least n' and 'more than n'. When these QPs are in this dedicated position for quantifiers, they are interpreted as genuine quantifier phrases, hence they are obligatorily distributive (Szabolcsi 1997). Bare numeral NPs cannot occur here. Numeral NPs modified by the distributive focus particle *is* 'also/even', however, are able to occupy this particular position. Accordingly, the numeral+*is* NPs must receive a distributive interpretation. These points are illustrated in some detail in what follows.

It is clear that in sentence (50) the quantified NP, *minden diák* 'every student' does not occupy a structural focus position since no verb–particle inversion is attested.

(50) [*Minden diák* DIST] *meg-oldott egy feladatot.*
every student VM-solved a task.ACC
'Every student solved a task.'

(50') *[*Minden diák* FOC] *oldott meg egy feladatot.*
every student solved VM a task.ACC

Sentences in (51) and (52) show that the quantified NP is not in a topic position either. In (51) the topical element and the quantified NP do not occur in free linearization, unlike multiple topics. This proves that they are not the same kind of syntactic position.

(51) [*A diák* TOP] [*minden könyvet* DIST] *el-olvasott.*
the student every book.ACC VM-read
'The student read every book'

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(51') *[*Minden könyvet* TOP][*a diák* TOP] *el-olvasott.*
every book.ACC the student VM-read

While topics can precede sentence adverbials (e.g. *fortunately*), examples like (52) demonstrate that universal quantifiers cannot.

(52) [*A dolgozatot* TOP] *szerencsére* [*mindenki* DIST] *le-adta időben.*
the test.ACC fortunately everyone VM-haned.in in.time
'Fortunately , everyone handed in the test in time.'

(52') *[*A dolgozatot* TOP] [*mindenki* TOP] *szerencsére le-adta időben.*
the test.ACC everyone fortunately VM-haned.in in.time

NPs modified by the additive/scalar distributive particle *is* 'also/even' have the very same distribution as *minden* 'every', i.e. they cannot occur in either focus or topic position (see 53–54).

(53) [*Két diák is* DIST] *meg-látogatta a professzort.*
two student DIST.PRT VM-visited the professor.ACC
'Two students also visited the professor.'

(53') *[*Két diák is* FOC] *látogatta meg a professzort.*
two student DIST.PRT visited VM the professor.ACC

(54) [*A diák* TOP] [*két könyvet is* DIST] *el-olvasott.*
the student two book.ACC DIST.PRT VM-read
'The student also read two books.'

(54') *[*Két könyvet is* TOP] [*a diák* TOP] *el-olvasott.*
two book.ACC DIST.PRT the student VM-read

The above enumerated examples (50–54) showed that inherently distributive quantified NPs obligatorily appear in DistP. However, not only inherently distributive quantified NPs but also other so-called positive existential quantifiers (e.g. *több mint* 'more than n', *legalább n* 'at least

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n') can be placed in the designated quantifier position. The syntactic tests in (55–56), namely the inversion test for focus position and the sentential adverbial test for topic position show that these quantified NPs may occupy the 'DistP' position.

(55) [*A dolgozatot* TOP] [*legalább hat diák* Dist] *le-adta.*
the test.ACC at.least six student VM-handed.in
'At least six students handed in the test.'

(55') *[*Legalább hat diák* TOP] [*a dolgozatot* TOP] *le-adta.*
at.least six student the test.ACC VM-handed.in

(56) [*A dolgozatot* TOP] *szerencsére* [*legalább hat diák* Dist] *le-adta.*
the test.ACC fortunately at.least six student VM-handed.in
'Fortunately, at least six students handed in the test.'

Positive existential quantifiers do not necessarily land in DistP, since the pre-verbal focus position of FocP can harbour these expressions as well. In a pre-verbal focus position, they may or may not have a distributive reading. As it was mentioned in the previous section, Szabolcsi (2010) contrasts the interpretation of the two structures given in (57.a) and (57.b). The quantified NP takes obligatorily distributive reading if it is situated in DistP. In (57.a), the interpretation of the clause includes that each child lifted the table individually.

(57) a. [*Több, mint hat gyerek* DIST] *fel-emelte az asztalt.*
more than six child VM-lifted the table.ACC
'There is a set of more than six children such that each element of this set lifted up the table'

In (57.b), the quantified NP is placed in FocP. In this position, both the collective and the distributive interpretation of the sentence are available. In the collective scenario, the clause is interpreted as describing a situation in which the children lifted up the table together.

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(57) b. [*Több, mint hat gyerek* FOC] *emelte fel az asztalt*
more than six child lifted VM the table.ACC
'Greater than six is the number n such that there was an event of table-lifting by children whose collective agent, or the individual agents of its subevents, numbered n'

Counting quantifiers, to use Szabolcsi's term (some of which are termed negative existential quantifiers by É. Kiss 2002; e.g. *kevés* 'few', *legfeljebb* 'at most'), occupy the focus position (58) and they cannot be raised to DistP (59) or to the topic field (59').[14]

(58) [*Kevés diák* FOC] *adta le a dolgozatot.*
few student handed.in VM the test.ACC
'Few students handed in the test.'

(59) *[*A tanárnak* TOP] *sajnos* [*kevés diák* DIST] *le-adta a dolgozatot.*
to.the.teacher unfortunately few student VM-handed.in the test.ACC
'Unfortunately, few students handed in the test to the teacher.'

(59') *[*Kevés diák* TOP] *sajnos le-adta a dolgozatot.*
few student unfortunately VM-handed.in the test.ACC

Definite and specific indefinite NPs (e.g. *néhány diák* 'some students') can occupy the topic position in the Hungarian sentence, as example (60) shows.

(60) [*Néhány diák* TOP] *szerencsére le-adta a dolgozatot.*
some students luckily VM-handed.in the test.ACC
'Luckily, some students handed in the test.'

Finally, noun phrases modified by cardinals (also known as numeral indefinites) can settle in a topic (61) or a focus position (62) as well. They occur in the quantifier field if an additive/scalar distributive *is* 'also' particle modifies them (see examples 53–54 above).

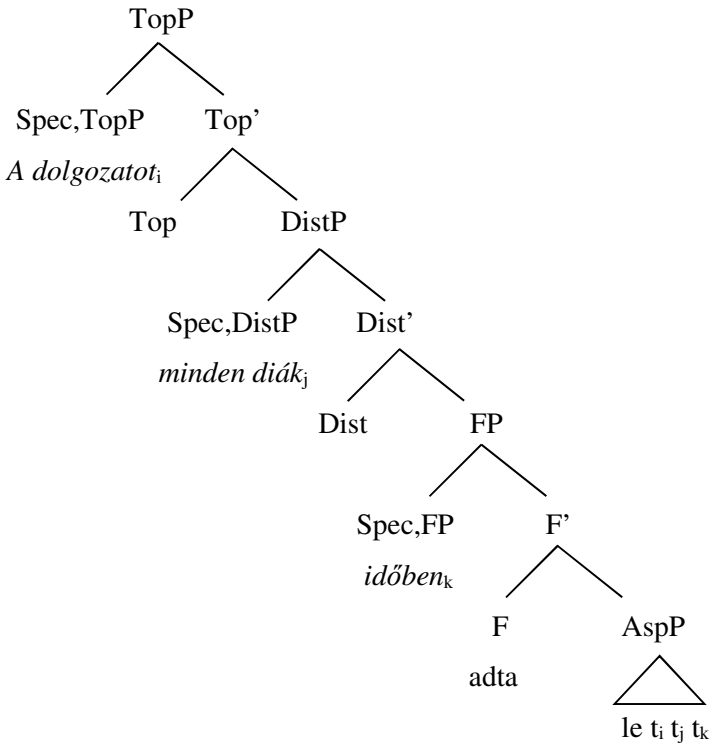
[14] However, counting quantifiers remain *in situ* in the presence of a pre-verbal focused constituent or the negative particle (É. Kiss 2002).

DOI: 10.15774/PPKE.BTK.2020.021

(61) [*Két diák* TOP] *szerencsére le-adta a dolgozatot.*
two students luckily VM-handed.in the test.ACC
'Luckily, two students handed in the test.'

(62) [*Két diák* FOC] *adta le a dolgozatot.*
two students handed.in VM the test.ACC
'Two students handed in the test.'

Summarizing the attested distributions of the quantified phrases, it can be concluded that there is a designated, predicate initial position (DistP) which precedes the focus of the sentence and it hosts inherently distributive quantifiers like *every*-NPs. This position can be filled by phrases modified by the additive particle *is* 'also', and by positive existential quantifiers as well. Figure 8 depicts the structure of the pre-verbal field containing a designated quantifier position, adopting a cartographic approach involving a hierarchy of functional projections.



A dolgozatot minden diák időben adta le.
the test.ACC every student in time handed.in VM
'Every student handed in the test in time'

Figure 7. Quantifier scope in the Hungarian pre-verbal field

DOI: 10.15774/PPKE.BTK.2020.021

As already mentioned, nothing in this thesis hinges on whether the above cartographic representation is assumed, or one in which pre-verbal quantifiers in the quantifier position are in an adjoined position (É. Kiss 1987, 1994, Surányi 2002).

Szabolcsi (1994: 23) argues that "Hungarian sentences wear their Logical Form on their sleeves" i.e. the surface structure and the logical form of the Hungarian pre-verbal field are isomorphic. She argues that the higher a quantifier is positioned in the pre-verbal field, the broader its scope is. In other words the Scope Principle (May 1985) works transparently in the case of the Hungarian pre-verbal field: the quantifier c-commands its scope not only at LF, but at surface structure as well. This phenomenon can be observed in sentences which contain more than one quantifier (or a quantifier and another preverbal operator e.g. negation or focus). In (63) the universal quantifier has wide scope over the existential quantifier, while (64) represents the opposite case, as the paraphrases reveal.

(63) *Minden professzor sok dolgozatot el-olvasott.*
every professor many test.ACC VM-read
'Every professor is such that he reads many tests.'

(64) *Sok dolgozatot minden professzor el-olvasott.*
many test.ACC every professor VM-read
'Many tests are such that they were read by many professors.'

2.2.4.2 *Post-verbal Quantifiers*

Quantifiers can also remain in the post-verbal field, as (65) illustrates.

(65) *A professzor el-olvasott minden dolgozatot.*
the professor VM-read every test.ACC
'The professor read every test.'

Continuing with the case of doubly quantified sentences, logically, three situations emerge from the fact that quantifiers can occupy post-verbal position in the surface structure: (i) both quantifiers are situated in the pre-verbal field (QP1 QP2 V sentences: see 63–64), (ii) one of the two quantifiers occurs in the pre-field (QP1 V QP2 sentences: see 66) and (iii) both quantifiers are post-verbal (V QP1 QP2 sentences: 67).

DOI: 10.15774/PPKE.BTK.2020.021

(66) [*Két professzor is* QP1] *el-olvasott* [*minden dolgozatot* QP2].
two professor DIST.PRT VM-read every test.ACC
'Two professors also read every test.'

(67) *A határidő előtt olvasott el* [*két professzor is* QP1] [*minden dolgozatot* QP2].
the deadline before read vm two professor DIST.PRT every test.ACC
'Two professors also read every test before the deadline.'

Considering these latter cases in (66 and 67), since one of the two quantifiers in (66) or both of them in (67) do not take the designated quantifier position in surface structure, scope ambiguity arises in the case of both sentences. The two readings are as follows.

(68) a. 'Two professors are such that they read every test before the deadline.'
b. 'Every test is such that it was read by two professors before the deadline.'

It is clear that both scope relations are available, although there are some preferences that yield one of the readings. These preferences have been already mentioned in the previous chapter (affected by thematic roles, quantifier types, world-knowledge, precedence, intonation, etc.).

Depending on the theory, there are different assumptions in the literature why the scope relation of the postverbal quantifiers is free, unlike in the preverbal field (see Szabolcsi 1994, 1997; Hunyadi 1999, 2002; Surányi 2002; É. Kiss 2002, 2010). The linear reading (68.a) is quite straightforward from a syntactic point of view: the first quantifier (QP1) occupies a pre-verbal operator position from which it c-commands its scope in the surface structure, while the second quantifier (QP2) remains in the post-verbal field. Assuming that QP2 remains relatively low in the structure, it falls in the scope of QP1. The question arises by what mechanism the inverse scope reading (68.b) can be derived. It may be derived by the overt movement of QP2 to its wide scope position in surface structure, coupled with the spell out of QP2 to the right of the verb (É. Kiss 2010). It may also be derived by covert raising of QP2 to its wide scope position (Surányi 2002).

It is not clear, however, whether the answer lies only in the realm of syntax. As discussed in the Introduction, prosody and information structure may have their own share in deriving inverse scope. This is the very issue that this thesis investigates in the case of QP1 V QP2 sentences (66). Depending on the empirical findings regarding the role of prosody and IS in

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quantifier scope, one possibility is to maintain the syntactic approach, according to which scope is uniformly read off of (overt or covert) syntactic structure. This corresponds to the Y-model of grammar (this view is best worked out for Hungarian by É. Kiss 2010). Another possibility is that scope is read off of prosodic structure, and it is co-determined by prosody and a quasi-lexical hierarchy of operators (Hunyadi's prosodic approach). Furthermore, it may also hold that information structure determines the relative scope of quantifiers (the IS-approach). The latter view is compatible with the Y-model just in case the relevant information structural differences are represented in syntax.

We may select among these options only if the relations between quantifier scope, prosody and information structure are clarified. The objective of this thesis is to bring empirical evidence to bear on this theoretical dilemma.

2.3 Prosody

Prosody and logical scope interpretation appear to exhibit interrelations across a variety of languages and constructions, hence it is highly relevant to the main concern of this thesis.[15] Recall for instance Krifka's double-quantified sentence for the disambiguating role of prosody in ambiguous sentences (discussed in Section 1.1, repeated here as example (8)).

(8) *Mindestens* / [$_{QP1}$ *ein* *Student*] *hat* \ [$_{QP2}$ *jeden Roman*] *gelesen*.
at.least one student have every novel read

a. 'There is at least one student such that he/she read every novel' linear scope
b. 'Every novel is such that it was read by at least one student.' inverse scope

(Krifka 1998: 80; ex: 16.b)

It was argued earlier in Section 1.1 that the two prosodic forms are associated not only with two distinct readings, but with two distinct information structures of the sentence as well. For instance, in the case of the inverse scope reading the quantified NP *at least one student* has contrastive topic information structural status. This section is devoted to prosody, a notion which encompasses supra-segmental features of speech, including intonation (melody), stress,

[15] This overview is based on the general view of prosody summarized in works like Féry 2006, Büring 2016, and Selkirk 1984.

DOI: 10.15774/PPKE.BTK.2020.021

rhythm, and intensity, among others. Section 2.3.1 enumerates the building blocks of prosodic structure generated by the autonomous system of prosody. Section 2.3.2 is concerned with (narrow) syntactic mapping, namely how syntactic units are reflected in prosody. Section 2.3.3 presents how information structural roles are reflected in prosody. Finally, 2.3.4 is devoted to the relevant properties of Hungarian.

2.3.1 Building blocks of prosodic structure and prosodic constraints

As it was mentioned above, in intonation languages like English or Hungarian differences in tonal contours are used for the expression of sentence-level pragmatic and semantic roles, rather than to distinguish lexical meanings (as in tone languages, e.g. Chinese). Intonation, which is primarily expressed phonetically in terms of fundamental frequency (F0), is realized within prosodic domains. Prosody is an autonomous generative system which has purely prosodic well-formedness constraints independently from the other components of the grammar (Büring 2016). It generates well-formed prosodic structures parsing continuous speech into hierarchically organized domains (prosodic constituents). According to the Strict Layer Hypothesis there are several constraints on prosodic structure.[16] One of them is headedness, which is a well-formedness constraint in classical theories of prosodic phonology. It requires each prosodic constituent to have one metrically strongest element, its head.

A mainstream representation of prosodic structure (Selkirk 1984, 1986), also known as prosodic hierarchy, has two layers:

(69) a. **Metrical structure**: prosodic units and their stress patterns
(syllable, foot, prosodic word, etc.)

b. **Intonational structure**: prosodic units
(intonational phrase, intermediate phrase), and
their tonal events (pitch accents and boundary tones)

Not only the terminology but the critical features of these components may differ from language to language. Below I present the particularities of stress-accent languages (to which

[16] Each prosodic constraint has been argued to be violable, although violations of such rules fall outside of the realm of this thesis.

DOI: 10.15774/PPKE.BTK.2020.021

group Hungarian belongs). Metrical prominence is realized by means of phonetic features on the affected syllable (in other terms, the head of the prosodic unit; see among others Selkirk 1984). Accents are associated with heads of Phonological Phrases, while Nuclear Accent is the head of the Intonational Phrase (or the main intonational phrase of the sentence; Nuclear Pitch Accent, NPA, or Nuclear Stress in Chomsky and Halle 1968). Features like duration (lengthening), F0 range, the maximum of F0 and the F0 slope of falling and rising accents may indicate prosodic prominence. Besides the prominent syllable itself, the effect of prominence on one unit may affect other prosodic objects as well. For instance, inserting a prosodic boundary — marked by a pause or by a boundary tone — results in perceiving the pre- or post-boundary positions as prominent (depending on left- or right-alignment). Two important features of sentence-level prosodic units are down-step and reset. Within a prosodic constituent, subsequent high tones often follow a pattern of relative lowering from one to the next which phenomenon is known as down-step. The notion of reset is a phenomenon when the absolute height of pitch accents after a boundary (optionally) resets to a higher frequency than the previous pitch accent.

2.3.2 Prosodic structure and mapping to syntax

Mapping constraints define how prosodic structure corresponds to syntactic structure. A Match-Based Approach (Selkrik 2011) assumes a default mapping between prosodic constituents and syntactic constituents, as illustrated in (70). It is worth mentioning that this mapping may be overridden by various other factors, including information structure.

(70) a. syntactic word → prosodic word
b. syntactic phrases → prosodic phrase
(any constituent above word level)
c. clause → intonational phrase

Another approach to the syntax–prosody mapping is the Edge-Based Approach (Selkirk 1986), which assumes that left, right or both left and right syntactic boundaries align with prosodic constituent boundaries. Syntactic structure – prosodic structure mismatches are naturally treated within an Edge-Based Approach, but are more difficult to treat in a containment based approach.

DOI: 10.15774/PPKE.BTK.2020.021

The prosodic structure in (71) illustrates the widely accepted claim that syntactic structure and prosodic structure are not necessarily isomorphic, since prosodic structure is often "flatter" than syntactic structure. In (71) no prosodic constituent corresponds to the subject NP, which contains a nominal phrase and a (non-restrictive) relative clause.

(71) (That man)$_{IP}$ (who no woman danced with)$_{IP}$ (was tall)$_{IP}$

2.3.3 Prosody expressing information structure

The focus information structural status clearly plays an important role in prosody in many languages. The focused constituent is highlighted by prosodic prominence in order to emphasize its novelty or importance in what is expressed. Reinhart (1995: 62) formulates a strong correlation between focus status and prosodic prominence in terms of the Stress–Focus Correspondence Principle:

(72) *Stress–Focus Correspondence Principle*
The focus of a clause is a(ny) constituent containing the main stress of the intonational phrase, as determined by the stress rule.

Deaccenting occurs after narrow focus, when focus is not in a position in which it would contain the default nuclear stress. For instance (73) represents the case of subject focus in English. The nuclear stress would fall on the object in all-new, or sentence-wide broad focus, SVO sentences. When the subject is the focus, it receives the nuclear stress, and the object is deaccented.

(73) [JOHN $_{Focus}$] bought a book.

In sentence (74) the default accent falls on the noun *book*. This allows the whole sentence to be interpreted as the focus (=sentence-wide focus). At the same time, in accordance with the Stress-Focus Correspondence Principle, it also licenses an object-focus and a VP-focus reading.

(74) [I bought a book $_{Focus}$].

Unlike focus, given elements are marked by means of "reduced prominence", generally in the post-focal domain (Féry and Samek–Lodovici 2006). Given content words may be

DOI: 10.15774/PPKE.BTK.2020.021

unaccented, or they may bear a phonetically not fully prominent accent. In fact, not every language has givenness-based deaccenting (e.g. Italian, see Ladd 2008). Naturally, if a given element functions as a narrow focus, it will bear the main accent of the sentence.

2.3.4 Prosody of the Hungarian sentence

As it was mentioned above, Hungarian is an intonational language in which differences in tonal contours are used for the expression of pragmatic and semantic roles, rather than distinguishing lexical meanings.

As for the word level, lexical-stress invariably falls on the left-most syllable of the content words (function words like articles and particles can be treated as non-accented elements). Phonological phrases and intonational phrases are assumed to be left-headed in Hungarian. The latter means that the nuclear pitch accent is left aligned in its intonational phrase (Hunyadi 1999, 2002, É. Kiss 2002, Szendrői 2003; however, according to Varga 2002 there is no NPA in a neutral sentence, where each element is equally prominent).

In an edge-based system (such as Vogel and Kenesei 1987), the mapping rule is to insert a left prosodic phrase boundary at the left edge of each major constituent of the sentence. Right prosodic phrase boundaries are then inserted right before each left boundary. Including the prosodic phrases thus formed within an intonational phrase (IP), this algorithm yields a prosodic structure like the one below:

(75) a. ((VM-V) (XP) (YP))$_{IP}$ = comment, NPA on VM-V
b. ((QP) (VM-V) (XP) (YP))$_{IP}$ = comment, NPA on QP

Sentence prosody and information structure are clearly interrelated, as it was shown in 2.1.3. Since Hungarian is a discourse configurational language, word order is routinely affected by IS (see 2.2.1). These two facts imply that intonation, information structure and syntax are interdependent in Hungarian and one of these three systems cannot be analyzed on its own without taking the other two into consideration. In the following, intonational phrasing in Hungarian is demonstrated by means of information structurally marked syntactic elements. It is essential to mention that intonational phrases and syntactic phrases do not necessarily overlap, as it was pointed out in Section 2.3.2.

DOI: 10.15774/PPKE.BTK.2020.021

2.3.4.1 *The topic–comment articulation*

As it was already put forth, the Hungarian sentence can be divided into two parts: the topic and the predicate (or *comment* from an information structural point of view). These two domains can be distinguished in the realm of sentence prosody as well. The nuclear stress falls on the left edge of the predicate. The topic and the predicate may form separate intonation phrases (É. Kiss 2002):

(76) [$_{\text{Topic}}$ *A* *professzor*] [$_{\text{Predicate}}$ *el-olvasta a dolgozatokat*].
(H*) (H*L)
the professor VM-read the tests.ACC
'The professor read the tests'

The accent type of the Hungarian aboutness topic may be high (H) or falling (HL), while the default accent type in comment is a falling type (HL) (Genzel et al. 2015).

2.3.4.2 *Focus, background and givenness*

As part of the comment, the focus constituent receives the nuclear stress and it forms a single IP with the syntactic constituents following it.[17] The so-called "stress eradication" effect of focus (argued to apply optionally by Kálmán and Nádasdy (1994); obligatorily by Varga 2002, Szendrői 2001) does not permit the rest of the constituents to the right of the focus in the sentence to bear an accent. Lexical stress remains attested in this IP on the word level (Kálmán and Nádasdy 1994, for experimental data: Genzel et al. 2015).

(77) [$_{\text{Topic}}$ A dolgozatokat][$_{\text{Predicate}}$ [$_{\text{Focus}}$ a professzor] olvasta el a határidő előtt].
(H*)(H*L L%)
the tests.acc the professor read VM the deadline before
'The professor read the tests before the deadline'

[17] The relevance of the maximum of F0-peaks of falling accents in prominence-marking in Hungarian is suggested by Varga (1975), who identifies narrow focus accents as a 'high fall' (falling from high to low) and broad focus accents as a 'low fall' (falling from mid to low) using a different theoretical framework.

DOI: 10.15774/PPKE.BTK.2020.021

The realization of the focus accent is a falling tone (according to Surányi et al. 2012: H*L) in the case of pre-verbal structural focus.

In the case of topicless sentences (broad focus sentences in which the whole sentence has a new information structural status) the whole utterance forms one single IP as shown in (78):

(78) [$_{\text{Predicate}}$ Kisütött a nap].
(*)

Usually givenness is associated with deaccenting (see the stress eradication generalizations above); however, only tendencies can be attested as well (see Genzel et al. 2015). Given topics are deaccented, and deaccenting is more frequent in the background following the focus if the constituent concerned is textually given (revealed in a lower F0-peak and narrower F0-range, as in Szalontai and Surányi 2020).

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3 TOWARDS RESEARCH QUESTIONS[18]

After considering all of the basic notions I provide a review of the literature that led to the specific questions formulated in this thesis. Although a variety of factors are known to limit or bias scope interpretation in doubly-quantified sentences, I focus only on the studies that investigate the interaction of syntax, prosody and information structure in scope taking mechanisms. I investigate these three factors since it is necessary to consider their effects together to tease apart their intricate roles in scope interpretation.

Recall that I grouped the theories into three main approaches. The Prosodic Approach posits a direct link between the phonetic form and the scope interpretation: it assumes that the scope relations can be "read off" from the prosodic relations in the sentence, in other words, in scopally ambiguous sentences it is prosody that can disambiguate between the possible interpretations by means of different prosodic realizations (Hunyadi 2002). Clearly, prosody is interrelated with some other factors, some extra-grammatical and some of which lie at the grammar/discourse interface, i.e. at the level of information structure. The Information Structural Approach assumes that the information structural role of a scope bearing element can determine its scope taking behaviour. The (non-contrastive) topic information structural role has frequently been associated with wide scope (Ioup 1975, Kuno 1982, 1991, Kempson and Cormack 1981, Reinhart 1983, May 1985, Cresti 1995, Erteschik-Shir 1997, Portner and Yabushita 2001, Krifka 2001, Ebert and Endriss 2004), independently of whether the topical element occupies a wide scope position in the syntax. The effect of focus as an IS role is decidedly more contentious. It has been linked to a narrow scope of the focused element in a range of studies (e.g. Diesing 1992, Kitagawa 1994, Kratzer 1995, Krifka 2001, Cohen and Erteschik-Shir 2002, Pafel 2006). A number of others, however, have associated it with wide scope interpretation (Williams 1988; May 1988; Langacker 1991; Deguchi and Kitagawa 2002, Ishihara 2002). According to Erteschik-Shir (1997), the choice crucially depends on the contrastiveness of focus: while non-contrastive focus is related to narrow scope, contrastive focus triggers wide scope. Finally, some aspects of information structure are interrelated –not only with prosody– but with syntax as well. For instance, topical elements may (or sometimes must) be syntactically displaced to a high, left peripheral position within the clause, from which

[18] This chapter is partly based on the literature review sections of the experimental studies in Surányi and Turi (2016, 2017, 2018).

DOI: 10.15774/PPKE.BTK.2020.021

they syntactically command their scope. (Overt and covert) syntactic structure is beyond doubt a key factor in the computation of scope relations. Typically a quantifier that linearly precedes another is easier to assign wider scope (Ioup 1975, Fodor 1982, Kurtzman and MacDonald 1993, Anderson 2004). Generally, what underlies the apparent effect of precedence is a structural factor, which only partially overlaps with linear order: namely, surface c-command (Reinhart 1976, 1983). Thematic and grammatical roles are also known to impact scope preferences (Ioup 1975, Filik et al. 2004). These factors are partially also represented in syntax (subjects and agents being located higher in the structure than objects and patients), and are intertwined with structural c-command relations. This partly explains why subjects and agents tend to take wide scope more easily than grammatical objects and themes, respectively.

What I called the Syntactic Approach in the first chapter assumes that in fact all scopal information is represented in syntax, and any prosodic reflexes and information structural factors relate to scope interpretation not directly, but through syntactic structure. In Chapter 1 I argued that the Syntactic Approach is favorable to the other two approaches insofar as it can handle many data in a more parsimonious model. In particular, the Syntactic Approach considers syntax (overt and covert structural relations) as the only interface between prosody and scope interpretation on the one hand, and between information structure and scope interpretation, on the other hand, which is in line with the restrictive Y-model of grammar.

In this thesis I investigate the choice between these approaches experimentally. In all experiments the surface word order is kept invariable: one of the scope taking elements is pre-verbal, while the other is post-verbal. The targeted linear or inverse scope reading is triggered by means of visual aids or paraphrases. The two other main factors, prosody and information structure, are subject to testing either separately or together. Specifically, throughout Type I experiments I tested how speakers prosodically realize the two scope readings of the ambiguous sentences out of context. In the series of Type II experiments I controlled the information structural status of the two scope-bearing quantified NPs in two subtypes. The first subtype of Type II experiments still targeted the two-way relation between prosody and scope reading in a production and in a perception study, while the information structural status of the scope bearing element was kept in check. Regarding this subtype of Type II experiments, Section 3.1 introduces the studies that are related to the effect of prosody alone, as well as the effect of prosody crossed with information structure, on scope interpretation. The other subtype of Type II experiments consisted of acceptability judgment studies that focused only on the effect of information structural status. Section 3.2 provides a brief literature overview related to this latter effect.

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3.1 Prosody, scope and the role of the information structure

In view of the potential effects of IS roles like topic and focus mentioned above, one of the main questions this thesis seeks to address is whether logical scope itself is expressed in intonation *independently* of contextual effects that may impose a topic or focus role on some part of a doubly quantified sentence. According to the Prosodic Approach, the relative logical scope of phrases can be read off sentence intonation, which in turn may be affected by syntactic and information structural factors. The Information Structural Approach assumes that logical scope is determined by the distribution of information structural roles in the sentence, and scope relations are encoded in prosody only in cases in which scope interpretation is a free rider on information structure.

3.1.1 Related studies

In the classical restrictive Y-model of transformational generative grammar (Chomsky 1981), sentence prosody, and phonetic form (PF) more generally, has an interpretive role, similarly to semantic interpretation in the logical form (LF). While syntax is (unidirectionally) mapped to both, PF and LF are not related to each other directly. Thus, any correlations between relations in LF and relations in PF must be mediated by syntax. A central case in point is information structure: differences in information structure are often simultaneously manifested in both LF and PF. A mainstream response to this state of affairs within the Y-model is to rely on dedicated features and configurations in the syntax that are interpreted at both interfaces (Jackendoff 1972; Rizzi 1997). As an alternative, it is possible to posit mapping algorithms at both interfaces that are sensitive to the same non-dedicated properties of the syntactic representation (for such a mapping rule at the LF interface, see Neeleman and van de Koot 2008). While the intonational effects of information structure have been studied extensively both from the perspective of the Y-model and beyond, it has received much less attention whether scope interpretation also affects intonation in systematic ways. If so, that would be another case in which distinctions in LF are reflected in PF.

In order to formulate this issue with more precision, it must be taken into account that intonation is affected in systematic ways by constituent structure itself (for a recent overview, see Selkirk 2011). Given the possible effect of syntactic structure on intonation, in cases in which a difference in quantifier scope is represented in terms of constituent structure, the scopal

DOI: 10.15774/PPKE.BTK.2020.021

difference might well manifest itself in intonation without that being a direct effect of logical scope. Thus, insofar as such an intonational difference can be derived solely on the basis of the structural difference, it poses no challenge to the Y-model. The remainder of this section presents instances of scope alternations that are not syntactically encoded in this manner, yet appear to license a divergence in intonational form.

A notable case in point is sentences like (7), repeated here as (79) in English, which can be uttered either with what Jackendoff (1972) calls an A-accent (a falling tone), or with what he calls a B-accent (a fall-rise) on the subject phrase (see also Bolinger 1965). The A-accent, characteristic of canonical intonation, corresponds to surface scope interpretation (79.a), while the intonationally marked B-accent triggers an inverse scope reading (79.b).

(79) All politicians are not corrupt.

a. all > not

b. not > all

The phenomenon is not limited to English: similar facts hold in various other languages (see the hat contour in German, Féry 1993, Büring 1997, and in Hungarian, Szabolcsi 1981).

The relation between intonational properties and scope interpretation has also been explored with specific regard to negation and quantified phrases in Greek by Baltazani (2002a, 2002b). She found that prosodic prominence or non-prominence of the quantified phrase correlates with its wide scope and narrow scope interpretation, respectively, with respect to negation.

Prosodic prominence was also shown to influence scope interpretation in doubly quantified sentences in Russian. In Russian this effect seems to be dependent on word order. In particular, Ionin and Luchkina (2015) found in a perception study that the availability of an inverse scope reading increases, compared to an appropriately matched baseline, when an indefinite quantified object phrase occupying a pre-verbal position in an OVS order is prosodically prominent. To test the effect of the information structure, the authors varied the sentences as to whether the target sentence followed a context sentence or not. Sentences in isolation were pronounced either with neutral intonation (Baseline version) or with contrastive stress on the determiner of the indefinite (Emphasis version). The experimental results showed that in the case of neutrally uttered sentences, there is a strong preference of the surface scope reading both in SVO and OVS word orders, which is in favour of Ionin's surface scope freezing hypothesis (Ionin 2003). However, sentences compatible only with an inverse scope scenario and not matching a surface scope reading, were still accepted 20–30% of the time. The authors

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draw two possible conclusions of this result: (i) the inverse scope is available but strongly dispreferred for processing reasons (for which they refer to Anderson 2004) or (ii) this rate of acceptance of the inverse scope interpretation is just noise.

Contrastive prosody facilitated the inverse scope reading of the pre-verbal indefinite numeral NP, but it did so only in the case of the scrambled, OVS order and not in the case of the SVO construction. The authors highlight that this latter is a new finding for Russian, although it is not straightforward how it can be analysed in the current theory. They underline that although German and Japanese scrambled objects can reconstruct and get narrow scope, this operation is available even in the case of neutral intonation in those languages, while in Russian it occurs only when the indefinite object bears contrastive stress. On the other hand, in these languages even the canonical word order (in which S precedes O) can be interpreted with inverse scope in cases in which the subject receives contrastive (rise–fall) contour, whereas nothing similar was found in the Russian data. These results cannot show any effect of prosody on its own on scope interpretation. Similarly, with particular regard to the prosodic encoding of quantifier scope, Antonyuk-Yudina (2011) found that although inverse scope was associated in Russian doubly quantified sentences with a marked prosody in production, participants performed poorly in perception in the disambiguation of sentences recorded as they were uttered on their inverse scope interpretation.

Turning to the Hungarian data, it is a well-established fact that there is a sharp difference between the pre-verbal field and the post-verbal field of the Hungarian sentence with regard to quantifier scope (see Section 2.2.4). While quantifier phrases (QPs) are generally interpreted only with linear scope in the pre-verbal field (excepting QPs functioning as contrastive topics), they may take inverse wide scope when they occur after the verb (e.g. Hunyadi 1981, Szabolcsi 1981, É. Kiss 1987, 2002). Thus, in the SOV sentence in (80.a) the subject unambiguously scopes over the object, while in the OSV variant in (80.b), only the opposite scope reading is available.

(80) a. [$_4$ *Négy lány is*] [$_\forall$ *mindegyik cikket*] *el-olvasta*. 4 > ∀
four girl DIST.PRT each paper.ACC VM-read
'Four girls are such that each of them read every paper'

b. [$_\forall$ *Mindegyik cikket*] [$_4$ *négy lány is*] *el-olvasta*. 4 < ∀
each paper.ACC four girl DIST.PRT VM-read
'Every paper is such that it was read by four girls'

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In contrast, sentences like (81), in which one of the quantified phrases is post-verbal, exhibit scope-ambiguity in the same way as (1) (and the same holds true of similar sentences where not just one, but both quantified expressions are after the verb).

(81) [$_4$ *Négy lány is*] *el-olvasta* [$_\forall$ *mindegyik cikket*].
four girl DIST.PRT VM-read each paper.ACC

a. 'Four girls are such that each of them read every paper' 4 > ∀

b. 'Every paper is such that it was read by four girls' 4 < ∀

According to the mainstream view, the lack of quantifier scope ambiguity in the pre-verbal field is due to the fact that quantifiers can only appear in an A-bar position when they are pre-verbal (É. Kiss 1987). On the assumption that elements occupying an A-bar position at surface structure must be interpreted there for the purposes of scope, scope isomorphism with linear order follows. On the other hand, since quantifiers in the post-verbal position are not necessarily in an A-bar position, they may take either surface or inverse scope, yielding scope ambiguity. Linear scope may be available to post-verbal quantified NPs without leaving their base position at surface structure.

As for the analysis of post-verbal inverse wide scope quantifiers in sentences like (81), proposals include overt A-bar movement to a pre-verbal structural position followed by stylistic postposing (É. Kiss 1987), overt A-bar movement to a right-adjoined position followed by free linearization of the main post-verbal constituents (É. Kiss 2010a), and an *in situ* analysis combined with covert Quantifier Raising (Surányi 2002). According to Brody and Szabolcsi's (2003) Mirror Theoretic analysis, quantifier phrases invariably raise to their scopal positions at surface structure. Their model holds, similarly in this regard to É. Kiss (1987, 2010a), that linear and inverse scopes are both obtained in overt syntax through distinct surface syntactic representations. Hunyadi's (1999, 2002) prosody-based approach offers a radically different alternative, according to which different scope interpretations are not associated with distinct overt or covert syntactic forms; they may differ, instead, in terms of prosodic structure.

The observation that sentences in which a (non-topic) quantified NP is linearly followed by a post-verbal universal quantifier are scopally ambiguous has been uncontested in the literature on Hungarian. What has been a matter of some controversy is whether and how prosody affects the available scope interpretations in particular sentences. In fact, the claim that prosodic prominence plays a key role in scope disambiguation was put forward in pioneering work on Hungarian sentence prosody by Hunyadi (1981, 1999, 2002). According to Hunyadi's (1999,

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2002) analysis, the relative scope of quantifier (or operator) phrases is determined in no small part by prosody. In particular, Hunyadi proposes, among others, the key generalization in (82) (one facet of his more general Principle of Scope Assignment, which relates scope to relative prominence relations; Hunyadi 2002: 210).

(82) If two quantified phrases XP and YP are located within a single intonational phrase IP, then if XP corresponds to the most prominent phonological phrase (=the head) of IP, then XP takes scope over YP.

Hunyadi further suggests that if two operator phrases XP and YP correspond to the most prominent phonological phrase in two *distinct* intonational phrases, then their relative scope is determined by independent lexico-semantic factors, expressed as an independently specified hierarchy of operator types. This operator hierarchy has what Hunyadi terms 'sentential operators' (including lexical phrases modified by the additive or scalar particle *is* 'also/even') higher than genuine quantificational NPs (like universally quantified NPs), which are in turn higher than focused NPs. For the complete hierarchy, see Hunyadi (1999: 79). According to Hunyadi's theory, if an operator XP and another operator YP head two distinct IPs, then the operator that is located higher on the logical hierarchy of operators will take wider scope.

To illustrate, consider the scopally ambiguous example in (83), which is assumed to be assigned one of the two intonational structures in (84).[19] In (84.a) the post-verbal indefinite object undergoes stress reduction, and the whole sentence forms a single intonational phrase (IP). In (84.b) the post-verbal object does not undergo stress reduction and it forms a separate IP. According to Hunyadi (1999, 2002), (84.a) has only a linear scope interpretation, by virtue of the principle in (82). (84.b), on the other hand, corresponds to an inverse scope reading, because the post-verbal indefinite NP modified by the distributive particle *is* belongs to an operator type that is higher on the operator hierarchy than the pre-verbal indefinite NP that functions as a focus. While Hunyadi himself does not classify NPs modified by the distributive particle *is*, since they behave syntactically (and with respect to their capacity to impose stress reduction on other elements) just like universally quantified NPs, they can be treated for the purposes of the logical hierarchy of operator types as genuine quantificational NPs.[20]

[19] Similarly to English, bare *kevés* corresponds to 'few/little'; while if it is preceded by an indefinite article, it is interpreted as 'a few/a little'.

[20] Alternatively, the *is* particle of numeral indefinites like *két cikket is* in the example above might be treated on a par with NPs with true additive/scalar *is*, which would categorize them as sentential operators. This type is even higher on the logical hierarchy of operator types than quantificational NPs.

DOI: 10.15774/PPKE.BTK.2020.021

(83) *Kevés diák olvasott el két cikket is.*
few student read VM two paper.ACC DIST.PRT
'Few students read two papers.'

(84) a. (KEVÉS diák olvasott el két cikket is)$_{IP}$
b. (KEVÉS diák olvasott el)$_{IP}$ (KÉT cikket is)$_{IP}$

Hunyadi's broader theory of language, based on data from Hungarian, English, Finnish, Modern Hebrew, and Japanese, assumes that there is a strong interrelation between the Logical Form (LF) and Phonological Form (PF) more generally. This theory assumes that although syntax defines argument structure, it does not necessarily define linear order; PF and LF work together on the linearization of the utterance. For Hungarian, Hunyadi proposes that it is relative scope that determines the linear ordering of elements in the clause, and this is apparent in the pre-verbal field of the language.

Hunyadi (1981, 1996, 1999, 2002) and É. Kiss (1987, 1992, 2002, 2010a) sharply distinguish stressed and unstressed post-verbal universal quantifiers. They claim that specific implicational relations hold between certain relative scope interpretations in doubly quantified sentences and the stressing (stressed or unstressed status) of post-verbal universal (and some other) quantifiers.

As reviewed in Section 1.1, Hunyadi (2002) suggests that in a sentence with a pre-verbal focus (in the example below, a quantified NPs in the structural focus position) and a post-verbal universal QP, if the post-verbal QP is not stressed (as in (85.a) below), then it can only take narrow scope with respect to the pre-verbal focus. For Hunyadi, this is because such sentences form a single intonational phrase, with the pre-verbal focus acting as the head (85.a'). Due to (82), the pre-verbal QP will take wider scope. É. Kiss (2010) also assumes the empirical generalization regarding scope in examples like (85.a). For her, the post-verbal universal QP falls in the c-command domain of the pre-verbal focus, and this is responsible both for the universal's narrow scope and its non-prominent phonological status. In examples in which the same universal QP bears primary sentence-level stress, as in (85.b), Hunyadi posits two IPs: one containing the pre-verbal focus and the verb (and the particle), and another containing the post-verbal QP (85.b'). In this prosodic structure, (82) is inapplicable. Because the head of the second IP, the universal QP is located higher on an independent lexical hierarchy of operator types than focus, in this case the universal QP will take wider scope. For É. Kiss (2010a), the

DOI: 10.15774/PPKE.BTK.2020.021

scope and prosodic relations in such examples are both derived directly from syntax. She assumes that in sentences like (85.b) the post-verbal QP is adjoined to the right of that part of the logical predicate phrase that properly contains the focus, as in (86.a). In this manner the universal QP c-commands the pre-verbal focus, therefore it scopes over it. Stress on the post-verbal QP is derived as follows. The Nuclear Stress Rule dictates in Hungarian that the highest phrase in each layer of the logical predicate receives primary stress. Thus, in (86.b) both the universal QP to the left of the pre-verbal focus and the pre-verbal focus itself receive primary stress. The case of (86.a) is analogous to (86.b), with the difference that this time the universal QP is to the right, rather than to the left. As the Nuclear Stress Rule is assumed not to be sensitive to directionality but to syntactic hierarchy, the wide scope universal is stressed in the same way as in (86.a).

(85) a. *KÉT DIÁK olvasott el minden cikket.*
two students read VM every paper.ACC
'Two students read every paper'
a' (KÉT DIÁK olvasott el minden cikket)$_{IP}$
b. KÉT DIÁK olvasott el MINDEN cikket.
b' (KÉT DIÁK olvasott el) (MINDEN cikket)$_{IP}$

(86) a. [[KÉT DIÁK olvasott el] MINDEN cikket]
b. [MINDEN cikket [KÉT DIÁK olvasott el]]

Based on the results of his own empirical investigation, Hunyadi (2002) qualifies the slightly more restrictive picture painted in his earlier works by adding that stressed post-verbal universals, depending on the context, may avail themselves of either narrow scope or inverse wide scope with regard to a pre-verbal focused (bare numeral) QNP. He assumes that in such cases the stress of the post-verbal QP is not primary but secondary and the two QPs are located within a single IP (87). With the primary stress falling on pre-verbal focus, it is focus that takes wider scope. In É. Kiss's (2010a) model, such examples can be explained by assuming that the post-verbal QP receives stress by virtue of the fact that it functions as an (informational) focus.

(87) (KÉT DIÁK olvasott el MINDEN cikket)$_{IP}$

DOI: 10.15774/PPKE.BTK.2020.021

This issue of whether and how prosodic stress and scope are related in Hungarian is at the centre of Gyuris and Jackson's (2018) experimental investigation. In Gyuris and Jackson's sentences, one of two arguments, a numeral indefinite NP, was invariably focused and occupied a pre-verbal focus position, while the prosodic prominence of the other, post-verbal argument was varied. The sentences were presented in a context that was intended to be neutral with regard to both information structure and scope interpretation. In a series of perception experiments Gyuris and Jackson found no effect of the stressing of post-verbal universals on their (narrow or wide) scope interpretation[21].

As the authors are careful to point out, it is possible that the intonational differences pertaining to scope interpretation are different from what their perception study relied on. More relevantly to the present concerns, it is conceivable that the distinctions that are of significance for scope interpretation obtain less reliably in the perception than in the production of sentence intonation, similarly to the case of Russian as reported by Antonyuk-Yudina (2011). Or, even assuming that the pertinent cues are perceived, they may not be reliably exploited in experimental tasks requiring participants to match perceived intonational forms with interpretations. Such asymmetries between perception and production have been recurrent in investigations of focus prosody.

For the sake of a complete picture, it is worth mentioning Jackson's (2008) paper, which investigates the prosody–scope relation in Hungarian from a psychological point of view, namely taking the language-processing system into consideration. Jackson (2008) offers a psychological solution that can maintain the Y-model. He rejects that the surface scope is isomorphic with the scope interpretation of the sentence; scope is read off of the LF structure where the (c-command based) Scope Principle is at work. Jackson argues that just like in English, covert QR is available in Hungarian (as in Surányi's 2002 proposal), and the surface c-command disambiguation is just an "extremely valid generalization, but it is not a true grammatical principle of Hungarian" (Jackson 2008: 99). As for the role of prosody, Jackson claims that intonation can *guide* the processor with probabilistic strategies while comprehending scope relations. However, this phenomenon does not mean that there is a direct link between PF and LF; these strategies are extra-grammatical. In other words, Jackson argues that there is no direct link between prosody and scope interpretation.

[21] É. Kiss et al. 2013 and É. Kiss and Zétényi 2017 investigated doubly quantified sentences in Hungarian child language. Their data show, that Hungarian pre-schoolers do not interpret the scope relations of the pre-verbal QPs linearly (as the adults do) but they are biased by the contextual—visual setup.

DOI: 10.15774/PPKE.BTK.2020.021

One point of note is that with regard to Hungarian sentences with a post-verbal universal quantifier similar to (1), in which the pre-verbal scopal element is structurally marked as a focus, what all these works agree on is that when it is stressed the universal may take wide or narrow scope, and when it is unstressed the universal is able to take narrow scope with respect to the pre-verbal focused element.

Summing up, there is some cross-linguistic evidence suggesting that it is possible for differences in scope interpretation to be matched with differences in intonational form, but there are also results that cast doubt on this idea.[22] A basic empirical question that I will therefore further explore experimentally in this thesis is formulated as Research Question (RQ) 1 (linked in Chapter 1 above to the Prosodic Approach):

(RQ) i. Does prosody affect the availability of linear and inverse scope interpretations in doubly quantified sentences?

If the answer to (RQ.i) is positive, a crucial further question to raise is whether in the instances in which prosody is found to be related to scope interpretation the two distinct interpretations differ only with regard to logical scope (i.e. whether they involve 'purely' scopal differences), or the scopal distinctions correlate with information structural distinctions, which in turn may ultimately be responsible for the observable intonational effects. This is the very issue that is addressed in the second Research Question (RQ.ii) (related in Chapter 1 above to the Information Structural Approach):

ii. Does IS mediate between prosodic realization and scope interpretation?

If the answer is positive to (RQ.ii), then a last, theoretical question I formulate is whether the different scope readings traced back to information structural differences are coded by distinct syntactic structural relations, as it is formulated in the third Research Question (RQ.iii.) (linked in Chapter 1 to the Syntactic Approach):

iii. Is there a syntactic distinction that underlies any IS difference that is responsible for any scopal effect found?

[22] For other cases in which scope appears to be correlated with intonational properties, see Sauerland and Bott (2002), Hirotani (2004), and Błaszczak and Gärtner (2005).

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3.2 Information structural status and scope reading

In this section I review the studies connecting the effect of the information structural status of a quantified NP to its scope taking behaviour. As it was already pointed out, the focus role is more intricate during the investigation, since topics are straightforwardly assumed to have wide scope interpretation. In this section I sketch the theoretical and experimental investigations concerning the effect of focus information structural role of a post-verbal universal quantifier in Hungarian.

3.2.1 Related studies

It is clear that information structure affects sentence prosody in systematic ways (Bolinger 1965, Halliday 1967, Jackendoff 1972, Ladd 1980, Lambrecht 1994). If the intonational differences correlated with scope oppositions turn out to be matched with information structural distinctions that can in themselves account for the intonational facts, then there is no reason to posit any independent mapping algorithm between logical scope (or its dedicated syntactic representation) and intonation.

To take a simple example, the inverse scope reading in sentences of the type illustrated in (77) above is known to be inseparable from the contrastive topic interpretation of the quantificational phrase that c-commands negation in surface structure (for an influential account of how this information structure interpretation gives rise to the inverse scope reading, see Büring 1997; for discussion, see also Chapter 1). As the intonation paired with inverse scope is identical to the intonation that is generally correlated with a contrastive topic interpretation, scope itself may be claimed to have no role to play in accounting for the intonational distinction (Ward and Hirschberg 1985, Kadmon and Roberts 1986). It might be argued that the differences in sentence prosody matching the scopal oppositions reviewed in the preceding subsection are all related to differences in information structure in a similar fashion.

The intonational pattern associated with the inverse scope reading of Russian OVS sentences with an indefinite object uncovered by Ionin and Luchkina (2015) corresponds to the contrastive focus interpretation of the object phrase. Indeed, it was suggested by Ionin (2003) that a contrastive reading of the pre-verbal indefinite is needed for the inverse scope interpretation to be available.

Similarly, the intonational difference in Hungarian analyzed by Hunyadi as in (84.a,b) also reflects an information structural variance. Namely, the prosodic pattern in (84.a), in which the

DOI: 10.15774/PPKE.BTK.2020.021

post-verbal indefinite is unaccented, arises when the pre-verbal indefinite is focused and the post-verbal indefinite falls within its background. In (84.b), on the other hand, either the pre-verbal indefinite is not focused, or if it is, then the post-verbal indefinite is not part of its background. Thus, (84.a) may be an answer to (88.a), and (84.b) can be a reply to (88.b). The two prosodic patterns correspond to different focus structures.

(88) a. How many students read two papers?
b. How many papers were read by few students?

(84') a. (*Kevés diák olvasott el két cikket is*)$_{IP}$
b. (*Kevés diák olvasott el*)$_{IP1}$ (*két cikket is*)$_{IP2}$
few student read VM two paper.ACC DIST.PRT
'Few students read two papers.'

Mutatis mutandis, the intonational correlates of the scope of negation with respect to a quantified phrase in Greek, as noted above, may also be rationalized in an analogous manner. In her treatment of the prosodic reflection of scope in negated Greek sentences, Baltazani (2002a, 2002b) argues in precisely this vein that the different intonational patterns found to be correlated with different scope readings emerge from differences in information structure, rather than from differences in scope interpretation alone (see also Baltazani 2006).

Baltazani conducted a series of experiments investigating the relation between quantifier scope and intonation. After testing different quantifier types, negation, and sentence adverbials in production as well as in perception, she has come to the conclusion that there is no direct link between prosody and scope. Namely, information structure mediates between the two: prosody reflects information structure and the latter helps to reconstruct the question under discussion (QUD). If QUD is scopally unambiguous, then the listener can access the intended meaning, while if the QUD is scopally ambiguous, both of the relevant interpretations remain available, and prosody cannot disambiguate between the readings.

According to Baltazani, in the case of negative sentences participants could choose the proper answer using only prosodic cues because the focus accent indicated which part of the sentence was new information (focus) and which part was discourse-old (background). Having these information structural statuses in mind, listeners were able to reconstruct an unambiguous QUD that led to the proper interpretation.

DOI: 10.15774/PPKE.BTK.2020.021

(89) a. How many problems did they solve?

NOT > MANY

b. How many problems didn't they solve?

MANY > NOT

(Baltazani 2002b: 70)

If the negative particle is focal, then it was not part of the QUD and it has wide scope interpretation: in the answer to (82.b) the verb had positive polarity, thus the negation scopes over the quantifier, while in the answer to (82.a) the negation scopes over only the matrix verb (since negation cannot scope over the *wh*-word in Greek like in English), yielding a negative polarity sentence in which the quantifier has wide scope.

On the other hand, in the case of her paired quantifiers experiment, Baltazani argues that the QUDs (see in 90), which were reconstructed from the prosodic cues, were ambiguous. The focal accentuation intended only which one of the quantifiers is new but it was not straightforward for the listeners which QP has wider scope.

(90) a. How many nurses helped every doctor?

b. How many doctors did three nurses help?

Based on the above described experimental results, Baltazani draws the following conclusion:

(91) If a potentially scopally ambiguous sentence is not disambiguated by context (i.e., by information structure), then prosody cannot help in the disambiguation of scope interpretations.

According to Baltazani, then, although intonation can provide information about the context in which a sentence can be appropriately uttered, it seems that there is no direct relation between scope and prosody. If the reconstructed context licenses only one interpretation in a potentially ambiguous sentence, then listeners can access the intended meaning. On the other hand, if the context does not deliver straightforward information about scope relations, intonation only helps to determine the information structural status of a quantifier but not its scope taking preferences. However, it is not clear why the focus status of the scope-taking element can determine its scope-taking potential in negative sentences and cannot do so in the case of doubly-quantified sentences. The more general question that arises is how the information

DOI: 10.15774/PPKE.BTK.2020.021

structural status of a quantifier affects its logical scope-taking behaviour. This question was investigated by Gyuris (2006, 2008) in Hungarian.

Gyuris (2006, 2008) —in her theoretical studies— examines the effect of the information structural status of a postverbal universal quantifier on its scope taking preferences with respect to a pre-verbal, structural focus. Gyuris (2006, 2008) focuses on sentences containing an operator in the preverbal focus position (focused NP (92) and a post-verbal, stressed universal quantifier[23]:

(92) [$_{\text{Focus}}$ *JÁNOST*] *ajánlotta* *MINDEN* *professzor.*
John.ACC recommended every professor
a. 'For every professor, it was John whom he/she recommended'
b. 'John is the person who was recommended by EVERY professor'

Gyuris (2008: 61)

As for the scope interpretation of such sentences, Gyuris assumes that sentences like those in (92) are ambiguous. Gyuris demonstrates that besides the well-attested wide scope interpretation of a stressed (and) post-verbal universal quantifier, it can take narrow scope with respect to a pre-verbal focused constituent in an appropriate context (a claim that is not in disagreement with Hunyadi 2002 or É. Kiss 2010a). Gyuris argues that information structure is crucial for the availability of certain readings: she presents different contexts, corresponding to different information structures, and points out that different information structural statuses correspond to different scope readings of a stressed post-verbal universal QP.

Information structurally, Gyuris assumes that the stress on the post-verbal determiner indicates the information structural focus status of the determiner only. She postulates, following Kálmán and Nádasdy (1994) that the focus status of the determiner does not spread to the NP as a whole. Furthermore, she argues that the stressed post-verbal quantified NP serves as the aboutness topic of the sentence if it takes wide scope interpretation (for references to works that link topichood to wide scope, see Chapter 1 and 2 above). Underlying the importance of information structure in scope interpretation, Gyuris presents discourses that satisfy her

[23] In Gyuris (2006), she deals only with pre-verbal, focused, subject NPs and post-verbal, object universals that are informational foci. Gyuris (2008) takes the negative existential quantifiers (which occupies the same structural focus position like focused NPs) into consideration as well besides the focused NPs. In her paper she includes example sentences in which the post-verbal UQP is the subject and the preverbal focus is the object (cf. agents take wide scope more readily). As her theory is concerned, Gyuris (2008) puts forward her theory (that she started to develop in Gyuris (2006)) in more detail.

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assumptions, namely (i) the post-verbal stressed QP can take narrow scope with respect to the pre-verbal, structural focus constituent (the linear reading of sentences like (92) is available); (ii) the stressed post-verbal universal determiner has a focus IS status; and (iii) the whole post-verbal quantified phrase serves as an aboutness topic of the sentence if it takes wide scope. She argues that not only post-verbal stress shows the focus status of the universal quantifier, but Halliday's (1967) three focus criteria as well.

Let us look at a few examples briefly. The first context (93) operates with the contrastive nature of foci. In (93), speaker B corrects the quantity that speaker A previously asserts. In this context, in which the universal quantifier *minden* 'every' is a focus, and is therefore stressed, the universal has wide scope over the pre-verbal focus.

(93) A: *JÁNOST ajánlotta legalább hat professzor.*
John.ACC recommended at.least six professor
'It is John who was recommended by at least six professors'
B: *Nem,* ***JÁNOST ajánlotta MINDEN professzor****.*
No John.ACC recommended every professor
'No, for every professor it was John whom he/she recommended'

Gyuris (2008: 68)

However, the linear scope interpretation of this sentence can be forced as well with a proper context. In the discourse in (94), speaker B utters a parallel assertion that does not contradict speaker A's statement but completes it with new information about John. Since there are professors who recommended others than John (namely, Eve), only the narrow scope reading of the universal is available.

(94) A: *ÉVÁT ajánlotta pontosan öt professzor.*
Eve.ACC recommended exactly five professor
'It was Eve who was recommended by exactly five professors'
B: ***És JÁNOST ajánlotta MINDEN professzor.***
and John.ACC recommended every professor
'And it was John who was recommended by every professor'

Gyuris (2008: 68)

DOI: 10.15774/PPKE.BTK.2020.021

The second type of contexts is furnished by a multiple question that requires pair-list answers. Gyuris (2006) presents two different contexts in which both the linear (95) and inverse scope reading (96) of the target sentence is available.

(95) A: *Az ünnepeltek közül hányat ki köszöntött fel?*
the celebrated among how.many who toasted VM
'Who toasted how many of the celebrated people?'
B: *Mari köszöntött fel három ünnepeltet,*
Mary toasted VM three celebrated.ACC
Juli köszöntött fel négy ünnepeltet, és
Julia toasted VM four celebrated.ACC and
JÁNOS köszöntött fel MINDEN ünnepeltet.
John toasted VM every celebrated.ACC
'Mary toasted three celebrated people, Julia toasted four celebrated people,
and it was John who toasted every celebrated person.'

(96) A: *Melyik ünnepeltet ki köszöntötte fel?*
which celebrated.ACC who toasted VM
'Who toasted which celebrated person?'
B: ***JÁNOS köszöntött fel MINDEN ünnepeltet.***
John toasted VM every celebrated.ACC
'For every celebrated person it was John who toasted him/her.'

Gyuris (2006) assumes that the contexts presented in (94) and (95) are less natural than those that trigger a wide scope interpretation of a stressed, (hence) focused post-verbal universal quantifier. She argues that this may be why the literature mainly deals with the wide scope reading of the post-verbal stressed quantifiers interpreted out of context. Having said that, the findings of Gyuris (2006, 2008) regarding the scope of stressed post-verbal universals are in line with Hunyadi's (2002) and É. Kiss's (2010) empirical generalizations regarding such occurrences of QPs.

Gyuris (2008) develops further her theory about the relation of information structure and scope interpretation and argues that the stressed post-verbal quantified NP is an aboutness topic of the sentence if it takes wide scope over the pre-verbal focus. She claims that in a corrective discourse, such as in (87), the post-verbal operator refers to a set of individuals in the discourse

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and the sentence predicates about the elements of this set. In (87) the predication amounts to claiming that all of the elements of the set of professors have the property of having been recommended by John. "This means that the universal DP [in this dissertation: QP or quantified NP] in fact possesses the properties normally attributed to topics" (Gyuris 2008: 71).

Gyuris's (2006, 2008) theory offers a prime example of taking IS into account when analyzing quantifier scope interpretations. She shows that depending on IS, there is indeed a narrow scope reading of the post-verbal stressed universal relative to a pre-verbal structural focus constituent. In this way, the stressed status of the post-verbal universal QP is divorced from its scope interpretation, and it is linked rather to its information structural status as focus. This accords well with Gyuris and Jackson's (2018) results from production, reviewed above. If Gyuris is correct then as far as stressed post-verbal universals are concerned, then there is no need to assume a mapping between prosody (PF) and logical scope (LF). For her the different ISs are potentially associated with different scope relations. This is in line with the Information Structural Approach.

What Gyuris's (2006, 2008) work demonstrates that it holds true even in sentences with a stressed universal QP that different information structures may be associated with different scope relations. What this work does not address, because if falls outside of its domain of interest, is whether a sentence can have variable scope interpretations in case its information structure is kept invariable, or if information structure truly fixes scope relations. Further, if scope is not fully fixed by IS then it also remains a question whether different scope readings that can be linked to differences in prosody in case IS is fixed. Another issue to be investigated is whether unstressed post-verbal QPs can have only narrow scope with respect to a stressed pre-verbal quantified NP or focus, as suggested by É. Kiss (2002, 2010) and Hunyadi (1999, 2002), and if so, whether this is due to information structural factors. In this thesis I investigate these issues both in speech production (an aspect not investigated by Gyuris and Jackson 2018) and in perception.

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4 EXPERIMENT TYPE I – NULL CONTEXT

This chapter presents a series of experiments investigating the scope interaction between two quantified NPs. The following pairs of phrases are employed: *négy előadó is* ('four singers too' = a bare numeral modified by a distributive particle, see Section 2.2.4) and *mindegyik* ('every') in Experiment 1; the negative particle *nem* ('no') and an NP modified by a bare numeral (henceforth: numeral indefinite) *négy nyomtató* ('four printers') in Experiment 2; and the negative particle and a quantified NP *több mint három nyomtató* ('more than three printers') in Experiment 3A. The latter production study is supplemented by a follow-up experiment: an acceptability judgment task (Experiment 3B) investigating whether the inverse scope reading of the target sentences in Experiment 3A is as acceptable as its linear scope counterpart.

I referred to these experiments as Type I in the introduction since they are similar in the aspect that the information structure was not controlled in the designs. Recall that these experiments address the (RQ.i) directly, repeated here:

(RQ) i. Does prosody affect the availability of linear and inverse scope interpretations in doubly quantified sentences?

In these experiments the target material was presented without any contextual aid; nevertheless, the possible scenarios (linked to the possible scope readings) were provided as disambiguating pictures or as textual paraphrases. Crucially, I used sentences (particularly in Experiment 1) in which it holds of none of the scope-taking elements nor of any other element in the sentence that (i) it needs to be interpreted as a topic or it can easily be assigned topic status even without context (see Section 2.1.4 and 2.2.4), or (ii) it needs to be interpreted as a focus or it can easily be assigned focus status even without context (e.g. 'few students'; see Section 2.2.4 above). However, at first glance, the focus sensitivity of negation and the particularities of the numeral indefinite played important roles in the case of Experiment 2 and 3.

This chapter is divided into three main parts. Section 4.1 presents the production studies focusing on one of the main research questions of the dissertation, while Section 4.2 is devoted to the follow-up acceptability judgment study belonging to Experiment 3. Lastly, section 4.3 is a short summary of the findings.

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4.1 Production studies

This section is primarily devoted to one of the main experimental questions (EQ) of this thesis – repeated in (EQ.i) – , namely the experiments scrutinize the interaction between prosody and logical scope without providing a wider context.

(EQ) i. Can prosody disambiguate between linear and inverse scope readings in the absence of context in speech production?

The theoretical background of this issue has been sketched in Section 3.1. As a short recap I focus only on the case of Hungarian, particularly on the analysis put forward in pioneering work on Hungarian sentence prosody by Hunyadi (1981; 1999; 2002). He formulated the claim that prosodic prominence plays a key role in scope disambiguation. According to Hunyadi's (1999; 2002) analysis, the relative scope of quantifier (or operator) phrases is determined by prosodic prominence relations. Hunyadi proposes the generalization, repeated here in (97).

(97) If two quantified phrases XP and YP are located within a single intonational phrase IP, then if XP corresponds to the most prominent phonological phrase (= the head) of IP, then XP takes scope over YP.

Furthermore, Hunyadi suggests that if two quantified phrases XP and YP correspond to the most prominent phonological phrase in two distinct intonational phrases, then their relative scope is determined by independent lexico-semantic factors (namely by an operator hierarchy). Investigating sentences given in (98), I expected that participants would realize the two readings of the sentence with two different prosodic forms.

(98) *Négy előadó is el-énekelte mindegyik melódiát.*
four singer DIST.PRT VM-sang each melody.ACC
'Four singers sang each melody.'

a. 'There were four singers each of whom sang each melody' Linear: four > each
b. 'Each melody is such that each of four singers sang it' Inverse: each > four

a. (Négy előadó is elénekelte mindegyik melódiát)$_{IP}$ Linear: 4 > ∀

DOI: 10.15774/PPKE.BTK.2020.021

b. (Négy előadó is elénekelte)$_{IP1}$ (mindegyik melódiát)$_{IP2}$ Inverse 4 < ∀

The linear scope reading would be pronounced in one IP headed by the first quantified NP (98.a), while the inverse scope would be realized in two IPs, having an accent on the second quantified NP object (98.b) being the head of the second IP.

The other two sub-sections explore the realization of the negative quantified sentences. Bearing in mind the above sketched theoretical consideration (see Section 3.1), I expect to find two different prosodic realizations of the two readings. The relation between intonational properties and scope interpretation has also been explored with specific regard to negation and quantified phrases in Greek by Baltazani (2002a,b). Hence I rigorously test such sentences in these sections seeking answer to the question whether prosody alone can disambiguate them in Hungarian.

Section 4.1.2 presents Experiment 2 in which I scrutinized negative sentences which contain a bare numeral indefinite phrase (99). Similarly, I expected two different prosodic realizations regarding the different scope relations.

(99) *Nem romlott el négy nyomtató.*
no broke VM four printers
'Four printers did not break down.'

a. (Nem romlott el négy nyomtató)$_{IP}$ Linear: Neg > 4
b. (Nem romlott el)$_{IP1}$ (négy nyomtató)$_{IP2}$ Inverse: Neg < 4

Section 4.1.3 investigates the scope interaction of the negative particle and a quantified NP. I chose the expression *több mint három* N ('more than three N') since it is an upward monotonic quantifier like every. In Hungarian, it can remain in the post-verbal field and can be associated with inverse wide distributive scope as well (100). Crucially, it does not have an inherent focus information structural status (cf. *kevés* 'few', see Section 2.2.4).

(100) *Nem romlott el több mint három nyomtató.*
no broke VM more than three printers
'No more than three printers broke down.'

DOI: 10.15774/PPKE.BTK.2020.021

a. (Nem romlott el több mint három nyomtató)$_{IP}$ Linear: Neg > [n > 3]

b. (Nem romlott el)$_{IP1}$ (több mint három nyomtató)$_{IP2}$ Inverse: Neg < [n > 3]

Essentially, the latter two sentences are clearly sensitive to information structure, as it was discussed by Baltazani. In her treatment of the prosodic reflection of scope in negated Greek sentences, Baltazani (2002a;b) argues precisely in this vein that the different intonational patterns found to be correlated with different scope readings emerge from differences in information structure, rather than from differences in scope interpretation alone (see also Baltazani 2006). This means that the results of these experiments could lead to the second research question formulated in Chapter 1 which addresses the interrelation of prosody and information structure in scope interpretation. This very question was tested with the Type II experiments described in Chapter 5.

To sum up, I tested whether – without any context – the participants realize any prosodic cues which can differentiate between the two readings of doubly-quantified and two types of negative sentences.

4.1.1 QP vs QP – Experiment 1

4.1.1.1 *The specific research question*

On the basis of the theoretical considerations already discussed in Section 3.1, I tested whether quantifier scope alone systematically affects sentence-intonation. I expected sentences associated with a linear scope interpretation differ in their prosody from sentences that receive an inverse scope reading (see Section 4.1 above). The specific question I investigated in this experiment is formulated in (101).

(101) Do Hungarian speakers differentiate between the two available
scope reading of doubly quantified sentences using distinct prosodic forms?

If native speakers do differentiate between the two readings by means of prosody, that would have two explanations. The first one is that there exists a direct link between prosody and logical form (cf. Prosodic Approach). The second explanation would bring the issue forward to the realm of information structure (cf. Information Structural Approach). Since I did not control the information structural status of the scope bearing elements, participants could associate the

DOI: 10.15774/PPKE.BTK.2020.021

target sentences with any suitable information structure (cf. Baltazani 2006). Hence the information structural status could be expressed in the prosodic form resulting in different realizations of the possible scope readings (in Chapter 5 I investigate this very effect using the same target sentences presented in Experiment 1).

4.1.1.2 *Methods and materials*

Target sentences were constructed in such a way as to avoid variation in any of the biasing factors identified in Section 2.14. Each target sentence in the experiment was scopally ambiguous and had the properties illustrated in (102) below. Their linearization was fixed throughout the experimental conditions: the sentence initial subject was a bare numeral indefinite modified by the distributive particle *is* 'also' which was followed by a complex transitive verb, and a universally quantified object. The complex verb consisted of a verbal particle and a verb, in the default uninverted order. The predicate was telic, perfective and appeared in past tense. The object was introduced by the strongly distributive universal quantifier *mindegyik* 'each', and it contained a noun denoting in the inanimate domain. The subject phrase is composed of the numeral 'four', a noun denoting in the human domain, and a distributive particle (*is*; see Szabolcsi 1997). The purpose of using this particle was to enforce a distributive interpretation, making the numeral indefinite subject similar in this regard to the inherently distributive universally quantified object. The distributive particle further ensured that the pre-verbal indefinite could not be construed as an aboutness topic: indefinites marked by the distributive particle must be part of the comment in Hungarian (see É. Kiss 2002). In the absence of such a distributive particle, a pre-verbal indefinite argument – followed by a complex verb in an uninverted VM–V order – is normally interpreted as an aboutness topic, a reading that I aimed to avoid. The linear and inverse scope readings of (102) are paraphrased in (102.a) and (102.b), respectively.

(102) *Négy előadó* *is* *el-énekelte* *mindegyik* *melódiát*.
four singer DIST.PRT VM-sang each melody.ACC
[Num] [N1] [PRT] [VM]–[V] [Q] [N2]
'Four singers sang each melody.'

a. 'There were four singers each of whom sang each melody.' four > each linear
b. 'Each melody is such that each of four singers sang it.' each > four inverse

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The visual stimuli used in Experiment 1 were designed to help participants conceptualize the intended scopal meanings. Bott and Radó (2007) have argued that abstract diagrams made up of dots and lines serve as highly suitable stimuli in sentence–picture verification tasks that require subtle judgments of quantifier scope interpretation. In a series of experiments testing alternative methods, they found that visual stimuli based only on global natural-looking images that depict complete scenarios without explicitly representing scope relations may introduce scope interpretation biases that result from extra-linguistic factors. While their results confirm both the validity of linguistic stimuli involving question–answer pairs and the validity of abstract diagrams involving sets of dots and lines, they demonstrate that the latter type of stimuli yields more consistent scope judgments across participants, that is, it is more reliable. In the present experiments, visual stimuli explicitly represented scope relations by sets of connecting lines, analogously to Bott and Radó's (2007) dots-and-lines diagrams. In difference to the latter type of stimuli, however, the different sets of individuals and objects in the diagrams were represented by natural-looking images rather than abstract dot symbols. This was done to further aid the correct assignment of the targeted scopal interpretation to experimental sentences.

Each display in Experiment 1 provided two diagrams side by side, which depicted the linear and inverse scope interpretations paraphrased in (102.a) and (102.b) above. One of these two scope diagrams appeared in a frame, while the target sentence itself appeared at the top of the screen. Figure 8 provides a sample target display (with glosses added below the target sentence for convenience). The diagram on the left hand side depicts a scenario corresponding to a linear scope reading, while the diagram on the right represents the inverse scope interpretation.

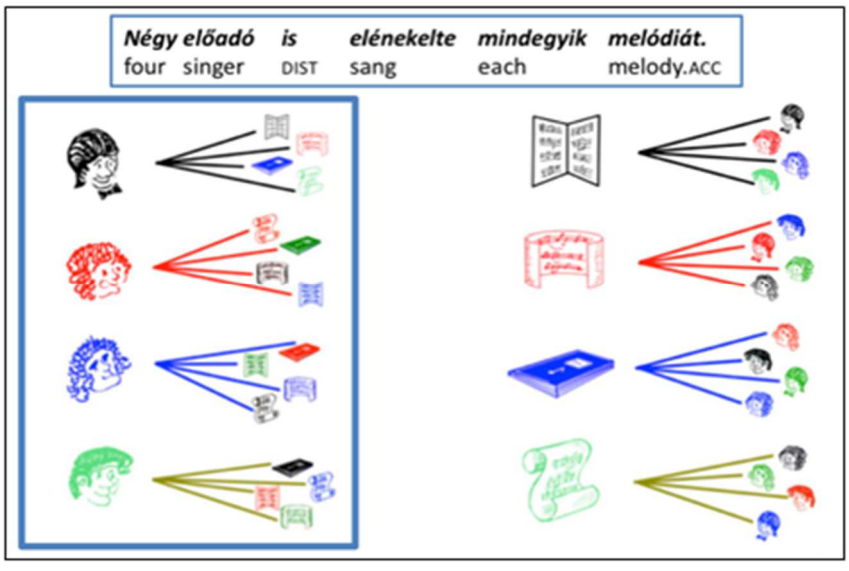

Figure 8. Sample picture stimuli for target items

DOI: 10.15774/PPKE.BTK.2020.021

The set of figures that correspond to the phrase with wider scope (in the case of Figure 8, the set of singers on the left-hand side diagram and the melodies on the right-hand side diagram) were arranged vertically at the left-hand side of each diagram, while the sets of figures corresponding to the narrow scope phrase (in the case of Figure 8, the sets of melodies on the left-hand side diagram; the singers on the right-hand side diagram) were consistently arranged along the right edge. Each member of the 'wide scope' set on the left side was linked with straight lines to members of one of the sets on the right-hand side. This served to make prominent the distributive interpretations that were targeted throughout. Individual figures within both the left-hand side 'wide scope' set and the right-hand side 'narrow scope' sets were coded with different colors and relative positions, in order to make it conspicuous that they are distinct individuals/objects, rather than the same individual recurring in different events. All lines starting from the same individual/object on the left-hand side were of the same color as the individual/object itself, and this color differed from the color of all the other lines in the picture. Each set of figures on the right-hand side whose members were linked to some particular individual/object on the left-hand side spatially formed a small group that was separated from other sets of 'narrow scope' figures below and above it by a clearly visible amount of extra space.

Participants were instructed to read out the sentence at the top in a way that it matched the framed diagram, as opposed to the unframed diagram. They were told that somebody else would listen to the recordings, and (s)he should be able to select merely on the basis of hearing the recorded sentence which of the two diagrams it was about (cf. Breen et al. 2010). Participants were asked to carefully inspect the pictures first and distinguish between the two scenarios depicted, before reading out the sentence at the top. They were allowed to read out the sentence as many times as they wanted, until they felt their prosodic realization was adequate. In cases in which the target sentence was read out more than once, only the last rendering was included in the analysis.

Experiment 1 involved two types of controls to check whether the participants comprehend and carry out their task properly. The first type of control sentences (Control 1), illustrated in (103), contained a definite noun phrase from which a restrictive relative clause has been extraposed. This relative clause contained an indefinite NP introduced by the word *egy* 'one/a(n)'. In example (103) the discontinuous definite NP is 'the monkey that is looking at a tangerine'. Control 1 sentences were ambiguous between two pertinent readings (see Figure 9). If the narrow focus within the indefinite NP is on the noun 'tangerine', then the relevant

DOI: 10.15774/PPKE.BTK.2020.021

alternatives to the propositions differ (only) with regard to the type of thing that the monkey is looking at. In this case, the element *egy* 'one/a(n)' preceding 'tangerine' is supposed to be interpreted as an indefinite article, and as such it is expected to be unstressed. If the narrow focus within the indefinite NP is *egy* 'one/a(n)', then *egy* is supposed to be interpreted as a numeral ('one') and is expected to be accented. In this case, the relevant alternative propositions differ (only) with regard to the number of tangerines that the monkey is looking at.

(103) *Az a majom narancssárga, amelyik* [NP [*egy*] [N *mandarint*]] *nézeget.*
that the monkey orange which a/one tangerine.acc looks.at
'The monkey that is looking at a/one tangerine is orange-colored.'

The difference between the two readings in Control 1 items does not involve logical scope, nevertheless, the pictures used with these items resemble the pictures included in the target items.

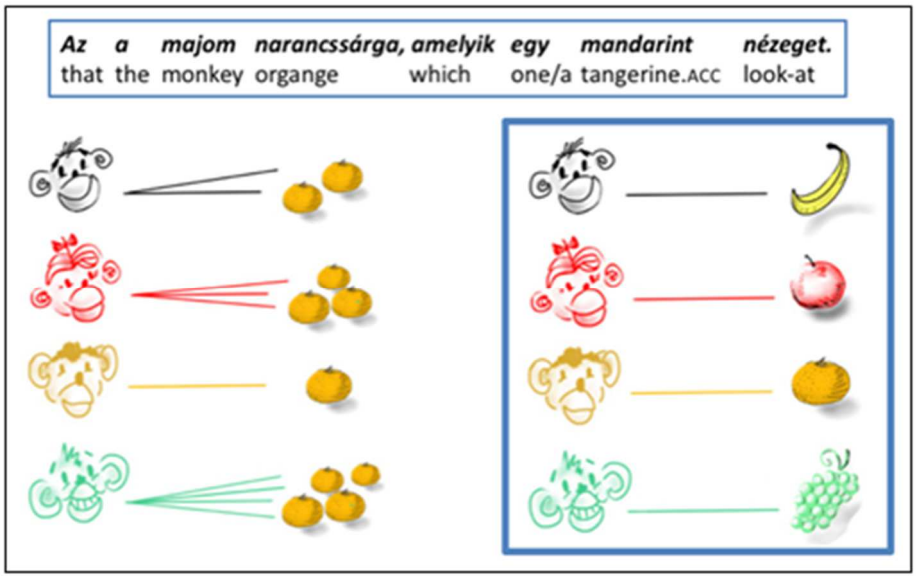

Figure 9. Sample picture stimuli for Control 1 sentences

Control 2 sentences are similar to the Control 1 set, but unlike in the case of Control 1, the two pertinent readings do not give rise to any further difference than just association with focus. Here the two interpretations depend on whether the adverbial or the noun plays the role of the focused information within the pre-verbal NP in sentences of the form illustrated in (104). If focus in (104) is on the noun, the relevant alternatives differ in terms of what type of individual sitting in the office has checked everything, while in the case when focus is on the adverbial,

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then the relevant alternatives differ with regard to the location where the policeman who has checked everything is sitting. The intonation of these two interpretations is expected to differ with regard to prosodic prominence relations. On the latter reading, paraphrased in (104.b), the main prominence of the pre-verbal NP should fall on the adverbial and the prominence of the noun should be reduced, while on the former reading, given in (104.a), the noun should be realized with full prominence.

(104) [*Az* [$_{\text{Adv}}$ *irodában*] *ülő* [$_{\text{N}}$ *rendőr*]] *ellenőrzött le* *mindent*.
The office.IN sitting policeman checked VM everything.ACC
'The policeman sitting in the office checked everything.'
a. 'Of the various people sitting in the office
it's the POLICEMAN who checked everything.'
b. 'Of the policemen sitting in various places
it's the one sitting IN THE OFFICE who checked everything.'

Picture stimuli in Control 2 items also superficially resemble pictures in the target conditions.

The Control 2 condition was included in addition to the Control 1 condition because it was not clear in advance of the experiment whether associating focus interpretation with different content words within a single syntactic phrase would yield sufficiently systematic differences in prosodic realizations. I expected Control 2 sentences to be able to confirm whether participants successfully process and prosodically express the difference between the interpretations targeted by the two figures they are presented with in this type of task. The prosodic expression of the difference in readings was expected to be more likely in Control 1 sentences, in which one of the two possible foci, namely *egy*, was an element that functioned as an indefinite article when non-focused and as a numeral when focused. This expectation was based on two considerations. First, as the difference between these two readings is part of the grammatical system of the language, their differentiation in prosody should be relatively systematic, with only very limited variation across speakers, items and utterances. Second, when construed as an indefinite article, the word *egy* is normally not merely unaccented, but also unstressed at the word level, contributing to a potentially greater difference between it and the focused realization, the latter of which is associated with a numeral interpretation.

The critical (target) conditions had five lexicalizations, while each of the control conditions had two. Six additional filler sentences were included. Five of these were scopally ambiguous

DOI: 10.15774/PPKE.BTK.2020.021

when interpreted in isolation, while one of them resembled Control 2 sentences and was ambiguous in a way analogous to sentences in the Control 2 condition.

10 lists of items were created. Each sentence, including all target, control and filler sentences, appeared twice within each list, once with each of its two targeted interpretations framed. Lists only differed in the order of the items. For each of the 10 lists, one other list was created, in which the framed figure containing the targeted interpretation of each sentence appeared on the opposite side of the display (i.e., it was balanced whether the targeted, framed interpretation appeared on the left or the right hand side). Each participant was randomly assigned two such pairs of lists, that is, four lists in total. Thus, four recordings of the entire set of stimuli were made with each participant. This yielded 120 tokens per person, as summarized in (105). The order of items within each list was pseudo-randomized.

(105) a. Critical items

5(lexicalizations) × 2(Scope readings) × 4(recordings) = 40

b. Control items

2(type 1/2) × 2(lexicalizations) × 2(readings) × 4(recordings) = 32

c. Filler items

6(lexicalizations) × 2(readings) × 4(recordings) = 48

The sentences were recorded in a soundproof room using a head-mounted microphone. A training session preceded the presentation of the experimental items. During the training session the experimental assistant was available for any clarification questions. 20 monolingual female speakers were recorded, all of them students. They were recruited from Budapest to participate in the experiment, and received financial compensation for their participation. Two speakers had to be excluded due to technical problems with their recordings. The data of the remaining 18 speakers (mean age: 20) entered analysis. All in all, I obtained and analyzed 360 recordings for each of the two scopal readings of target sentences (=18 speakers x 5 lexicalizations x 4 recordings).

As reviewed in Section 2.3.4, the most common prosodic device that appears to be employed across languages to express logical scope differences is the manipulation of prominence relations, and this is also the means through which Hungarian has been claimed to encode the difference between linear and inverse scope, at least in some sentence types (see Hunyadi 1996, 2002). I therefore investigated prosodic prominence relations across the different conditions. In particular, the vowel of the first syllable of the numeral and the universal quantifier as well as

DOI: 10.15774/PPKE.BTK.2020.021

each content word were analyzed in all target sentences (Vowel=Num/N1/VM/V/Q/N2). Similarly, the first vowel of each content word was analyzed in Control 2 sentences and in the relative clause of Control 1 sentences, in which the vowel in *egy* 'a/one' was also included in the analyses. These vowels were selected on the basis of the hypothesis that Hungarian encodes prominence relations in terms of the prominence of stressed syllables, lexical stress is uniformly aligned with the first syllable of words, all content words are lexically stressed by default, pitch accents can only be associated with syllables bearing word-level stress, and all lexically stressed content words are accented by default (i.e., Hungarian is a dense pitch accent language; for a lucid overview, see Varga 2002).

The acoustic cues that were analyzed measured parameters commonly associated with prominence at the sentence level. These include the duration and the scaling of pitch excursion, measured in terms of fundamental frequency (F0), of the vowels identified immediately above (see Ladd 2008). The default accent type in the non-topic part of assertive declarative sentences in Hungarian is a falling accent (analyzed as H*+L by Surányi et al. 2012). As Genzel et al. (2015) found that steepness of falls is associated with prominence (narrow focus is realized with a steeper fall than broad focus, as measured on a designated element), I also calculated the rates of falling realizations for each stressed vowel, and I measured the steepness of these falls.

The sound files were annotated for segment boundaries automatically using ProsodyLab Aligner (Gorman et al. 2011). The following data of each selected vowel were extracted with the acoustic analysis software Praat (Boersma 2001): values of F0 maxima and minima, the alignment of F0 maxima and minima within the vowel, pitch range, duration and intensity. The F0 values were transformed into semi tones by the speaker (using 20Hz as a base value). The F0 ranges and slopes were calculated using Hz values, in each case subtracting the F0 minimum from the F0 maximum (= F0 range (Hz)), and the time point of the F0 minimum from the time point of the F0 maximum (= F0 slope duration (s)). The F0 range was divided by the F0 slope duration, which yielded the value of the F0 slope (Hz/s). Vowels were categorized into those with falling pitch (i.e., vowels in which the F0 minimum followed, rather than preceded the F0 maximum) and those with non-falling pitch. The proportion of falls was calculated for each vowel by dividing the number of falling realizations with the number of all realizations.

In addition, I searched for any pauses (silent intervals) before and after stressed words, relying on the assumption that prosodic breaks tend to indicate prosodic boundaries, and prosodic boundaries are not infrequently utilized in languages to mark an immediately preceding or following element as prosodically prominent (Beckman 1996, Jun 2005, 2014; for

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Hungarian, see Mády and Kleber 2010; for the claim that focus prominence affects prosodic phrasing in Hungarian, see Vogel and Kenesei 1987).

4.1.1.3 *Results and analysis*

Pauses required no statistical analysis since the forced aligner did not detect any measurable silent intervals either within the test sentences or within the control sentences.

I analyzed the parametric data with linear mixed effect models (using R, R Core Team 2017), with the relative Scope of the two quantified phrases (levels: Linear or Inverse) and the Vowel (levels: the first vowel of each content word) as fixed factors, and Subject and Item as random factors. For each measured dependent variable, model selection employed stepwise backward elimination based on AIC values, starting from the full model with maximal random effect structure, until the most parsimonious convergent model was reached. Each of the selected models minimally included random intercepts for both Subjects and Items.

The analysis of F0 maxima (st) did not reveal a main effect of the Scope factor ($\chi^2(1)=0.02$; $p=0.89$). The most parsimonious model contained only the Vowel as a fixed factor, and Item and Subject as random factors with Scope and Vowel as random slopes without interaction between them. The Scope factor had no significant effect on pitch range (Hz) either ($\chi^2(1)=0.09$, $p=0.77$), for which the most parsimonious model included only Vowel as a fixed factor, and Item and Subject as random factors without random slopes.

The proportion of vowels (within each level of the Vowel factor) that were realized with falling pitch was analyzed using logistic regression mixed models. I detected no significant difference in the rate of falling realizations between the two Scope readings ($\chi^2(1)=0.06$; $p=0.81$). Scope ($\chi^2(1)=1.67$, $p=0.19$) was not found to significantly affect the F0 slope value of vowels realized with a falling pitch. The most parsimonious model of F0 slope involved only Vowel as a fixed factor, Item was included without random slopes, and Vowel remained as a random slope in the Subject factor.

The data show no significant effect of the Scope factor on vowel duration (ms), only a possible tendency is revealed ($\chi^2(1)=3.38$, $p=0.07$). An interaction was found between the two fixed factors ($\chi^2(1)=21$, $p<0.001$). The most parsimonious model consisted of the interaction between the fixed factors and the random factors Item and Subject, of which the latter included Vowel as a random slope.

Finally, the analysis of the intensity data (dB) neither revealed any effect of the Scope factor ($\chi^2(1)=2.02$, $p=0.15$), nor an interaction between the fixed factors ($\chi^2(1)=4.53$, $p=0.48$). The

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most parsimonious model contained the interaction between the fixed factors and the random factors, Item with Vowel as a random slope, and Subject with a random slope that has the fixed factors with interaction.

Figure 10 shows the mean values of the F0 maxima of stressed vowels in semi-tones in the two Scope conditions, Figure 11 represents F0 range data, Figure 12 depicts F0 slopes of vowels realized with a falling pitch, while Figure 13 shows vowel durations and lastly, Figure 14 depicts the data of intensity, showing the root mean square (rms) of the dB data. Error bars indicate standard errors of the mean values.

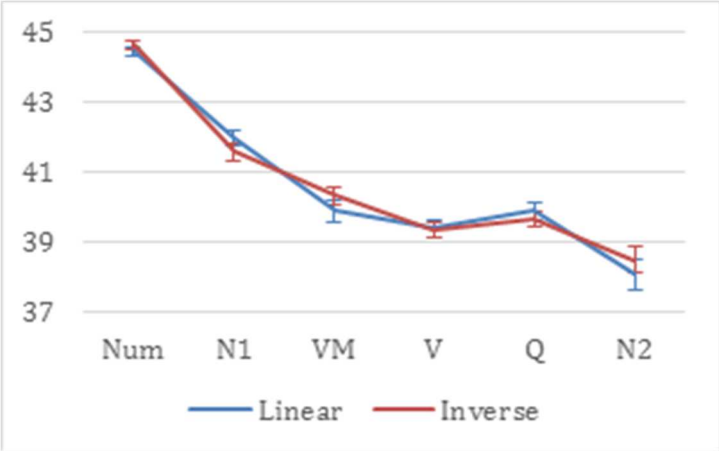

Figure 10. F0 maxima (st; with SE)

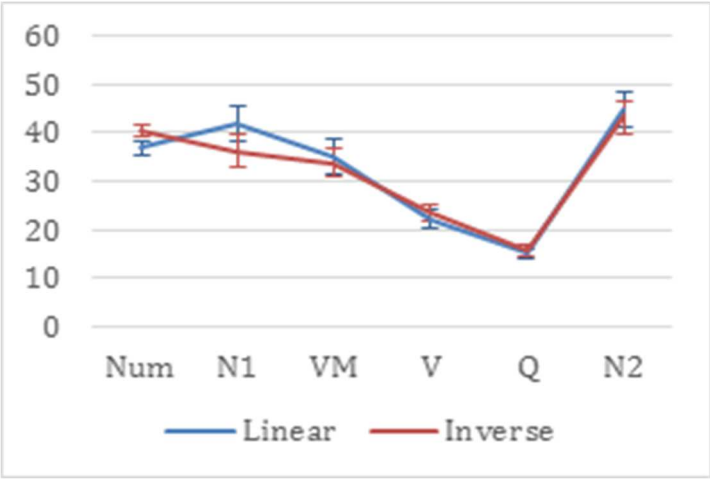

Figure 11. F0 range (Hz; with SE)

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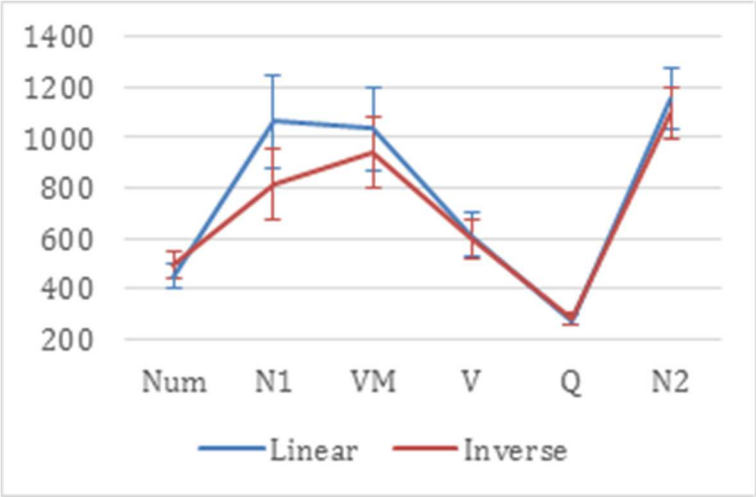

Figure 12. F0 Slope (Hz/s; with SE)

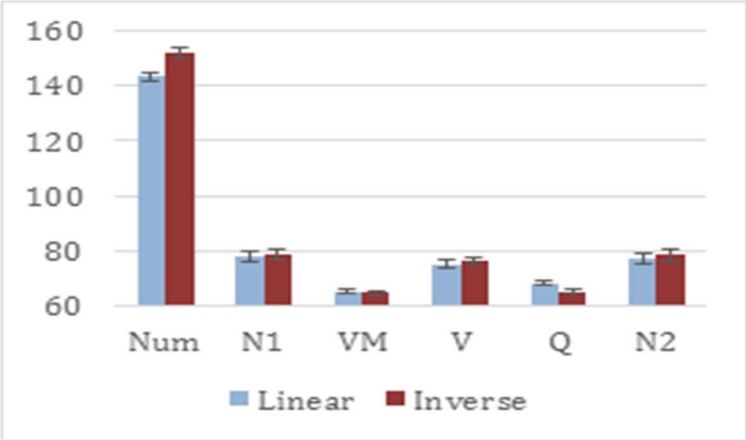

Figure 13. Duration (ms; with SE)

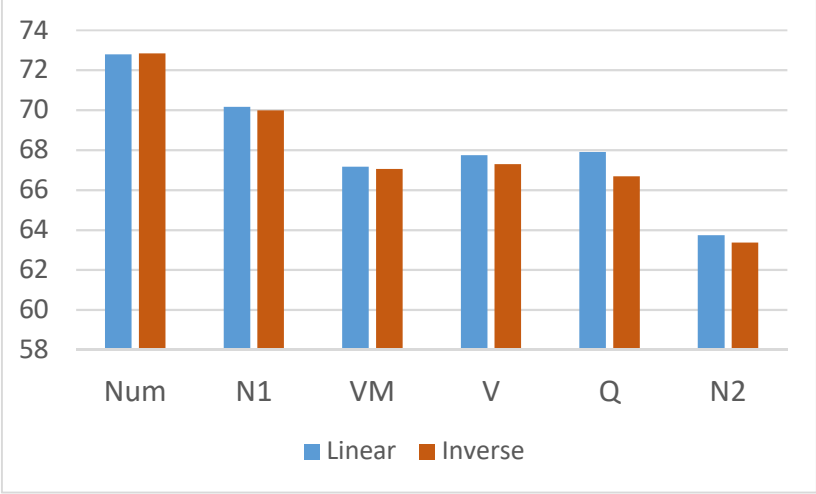

Figure 14. Intensity (dB)

Control conditions were statistically analyzed in the same way as the critical conditions, with the difference that the two targeted interpretations were coded as two levels of the factor Focus. The levels were labeled as Early and Late focus, corresponding respectively to whether focus interpretation was associated with an element occurring early on within the sentence, or with an element positioned later.

In Control 1 conditions the analysis of F0 maxima revealed no main effect of the Focus factor ($\chi^2(1)=0.07$, p=0.79). The most parsimonious model consisted of the interaction of the two fixed factors, the Item random factor and Vowel as random slope in the Subject random factor. With regard to F0 range, Focus had a main effect ($\chi^2(1)=7.99$, p<0.001), and it exhibited interaction with Vowel ($\chi^2(2)=36.82$, p<0.0001). The most parsimonious model contained Focus as a fixed effect and interaction between the two fixed factors, along with Item as random factor, and Subject including random slope of the two fixed factors without interaction between them. Post hoc pairwise Tukey comparisons revealed a difference between the mean F0 ranges of the numeral-determiner *egy* 'a/one' across the two Focus conditions (*t-ratio*=-6.12, p<0.0001), which was of a substantial size (Early: M(143)=104.77[166.01] and Late: M(144)=35.36[63.14]). Regarding F0 slope, no main effect of Focus ($\chi^2(1)=0.06$, p=0.81) and no interaction between the fixed factors ($\chi^2(1)=4.10$, p=0.13) were found. The most parsimonious converging model of F0 slope, nevertheless, contained interaction between the fixed factors, along with a Vowel random slope in the Item factor, as well as interaction between the two fixed factors in the Subject factor as random slope.

Focus ($\chi^2(1)=3.95$, p=0.05) did exhibit a main effect in the analysis of duration, and there was a significant interaction ($\chi^2(2)=37.67$, p<0.0001) between the two fixed factors. Post hoc pairwise Tukey comparisons uncovered a significant difference of a non-negligible size in the two realizations of the vowel of the numeral-determiner (*t-ratio*=-5.33, p<0.0001; Early Focus: M(144)=105.21[39.44], Late Focus: M(144)=66.04[32.65]). The vowel of the verb also exhibited a durational difference (*t-ratio*=2.06, p=0.04), but this was of a negligible size (Early Focus: M(144)=100.90[27.83], Late Focus: M(144)=106.04[26.97]).

Turning to Control 2 data, the most parsimonious model, which included Focus as a fixed effect, alongside Item with Scope as a random slope and Subject with Vowel as a random slope, revealed a significant main effect of Focus ($\chi^2(1)=4.16$, p=0.04) on F0 maxima, and a strong interaction between the fixed factors ($\chi^2(5)=20.69$, p<0.001). Post hoc pairwise Tukey comparisons detected a difference in the two Focus readings of the word that functioned as the focus in the Early Focus condition (*t-ratio*=-2.38, p=0.02; Early Focus: M(141)=38.54[5.79]; Late Focus: M(144)=40.36[4.97], and of the word that functioned as the focus in the Late Focus

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condition (*t-ratio*=-3.83, p<0.001; Early Focus: M(134)=40.65[9.75]; Late Focus: M(140)=43.58[9.37]). With regard to F0 range, no main effect of Focus (χ^2(1)=1.82, p=0.18) was found during model selection. The most parsimonious model contained only Vowel as a fixed factor, and Item with Vowel as a random slope and Subject without random slopes. Further, no main effect of Focus (χ^2(1)=3.07, p=0.08) was uncovered by the analysis of F0 slopes either. The most parsimonious model contained only Vowel as a fixed factor, and Item with a Vowel random slope, along with Subject without random slopes, as random factors.

Focus did not show a main effect on duration (χ^2(1)=1.02, p=0.31), while its interaction with Vowel was significant (χ^2(1)=114.75, p<0.0001). The most parsimonious model contained interaction between the two fixed factors, with Focus and Vowel (without interaction between them) as random slopes in Item, and Vowel as a random slope in Subject.

4.1.1.4 Interim summary

This experiment investigated doubly quantified sentences in order to test whether quantifier scope systematically affects the prosody of the sentence. Target sentences contained no topic and no inherently focused or focus-sensitive element, and were presented without a context. **The measured acoustic cues of prosodic prominence relations were not found to exhibit any significant differences across the two scope conditions.** The significant effects found in the control conditions, on the other hand, show that participants properly attended their task. They were able to link the different depicted interpretations to ambiguous sentences, and they systematically expressed the differences between targeted interpretations using phonetic cues of relative prominence in their production.

The two readings of each of the two sets of control sentences, which gave rise to clear acoustic distinctions in the data, differed with regard to their focus structure. In Control 1 sentences these distinctions affected the adjustment of the duration and the F0 range of the word associated with focus in the Early Focus condition. Control 2 sentences showed a somewhat different pattern. In their case the interpretational distinction was revealed in the F0-maximum measured in the two words functioning as the focus in the Early and the Late Focus condition, respectively. Although the two sets of control conditions behaved differently, they crucially exhibited acoustic differences as a function of the two available readings. Recall that in Control 1 sentences the word associated with focus in the Early Focus condition, namely *egy* ‘a/one’, can only be interpreted as a numeral in that condition, while it is interpreted as an indefinite article in the Late Focus condition. Thus, the difference between the two focus readings was

DOI: 10.15774/PPKE.BTK.2020.021

expected to be revealed in the phonetic realization of the numeral/determiner *egy* 'a/one' (see Section 3.1.1): this word was expected to be accented in one of the two readings and unstressed (lacking even word-level stress) in the other reading. The effect that Focus had on the duration and the F0 range of *egy* 'a/one' in Control 1 conditions bears out this expectation. As noted, the effect of Focus manifested itself in a different acoustic parameter in Control 2 sentences, in which the F0-maximum of the focused word was boosted, while no effects on duration or F0 range were detected. Although this divergence between the 'strategies' of prosodic marking in Control 1 and Control 2 is interesting in itself, it is not pursued here as it does not concern the topic of this thesis. It is worth pointing out, however, that of the two types of controls, Control 2 can be considered to be the more canonical case, since in Control 2 the divergence between the two focus interpretations does not correlate with additional prosodically relevant grammatical differences, as it does in Control 1.

4.1.2 Scope interaction between: Neg vs. NumP – Experiment 2

Since no effect of scope was found in the case of doubly quantified sentences, I turned to negative sentences containing an indefinite bare numeral noun phrase. The motive of using negative sentences has already been explained in section 4.1. As a short reminder, these sentences also have two possible readings, since the scope of the negative particle and the existential quantifier associated with the bare numeral can interact with each other.

4.1.2.1 *Specific research questions*

Examining negative sentences, I was searching for possible answers for the question formulated below in (106).

(106) Do Hungarian speakers differentiate between the two available
scope-readings of negative sentences containing a numeral indefinite
by means of distinct prosodic forms?

Recall that Baltazani (2006) found participants differentiating between the two readings both in production and perception in the case of negative sentences. She claims that the information structural status of the elements was reflected in prosody. In this experiment I used a postverbal indefinite bare numeral in a negative sentence. Being aware of Baltazani's results, I expected

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that the speakers would realize the two scope readings in different prosodic forms (see 99.a and 99.b above in Section 4.1) because the post-verbal indefinite element could be easily associated with any information structural status – and different information structural status should be reflected in the prosody. Specifically, negation is sensitive to the focused element in its syntactic domain, hence I expected different prosody for the case in which the participants interpreted the post-verbal indefinite as a focus. However, as I did not control the information structure I remain agnostic about the true nature of the interaction between scope-reading and information structure. The next chapter (Chapter 5) is devoted to the latter question.

4.1.2.2 *Materials*

The experiment presented in this section encompassed ambiguous negative sentences formed with a post-verbal numeral indefinite as given in (107).

(107) *Nem romlott el négy nyomtató.*
not broke VM four printer
'Four printer did not break down.'

a. 'It is not true that four printers broke down.' Neg > 4
b. 'For four printers, it is true that they did not break down.' Neg < 4

Similarly to the previous experiment (see section 4.1.1) the sentences were accompanied with disambiguating pictures. The left-hand side of Figure 15 provides a scenario in which the numeral indefinite *négy* ('four') takes inverse wide scope over the negative particle *nem* ('no'), while on the right-hand side the figure provides the linear narrow scope of the indefinite numeral. There were 9 natural-looking pictures displayed in both scope-readings. I used different colours, red and green to highlight the affected objects in the pictures, and I arranged the affected ones to the left of each set. In Figure 15, the linear scope reading scenario (107.a) is depicted on the right-hand side of the picture: among the 9 printers, there are only 3 machines which broke down – the broken printers are visualized vividly with red background and additional visual cues (e.g. smoke). On the left-hand side, the framed picture in Figure 15. illustrates the inverse scope reading of the target sentence (107.b), i.e. among the 9 printers there are four machines which did not break down – the functioning machines appear on the left of the set in green background.

DOI: 10.15774/PPKE.BTK.2020.021

The task of the 18 participants (the same 20 participants who were engaged in Experiment 1, minus the excluded 2 – as reported in 4.1.1) was to read out the sentence appearing at the top of the screen in a way it would be suitable for the framed picture (i.e. scope reading) just as in Experiment 1.

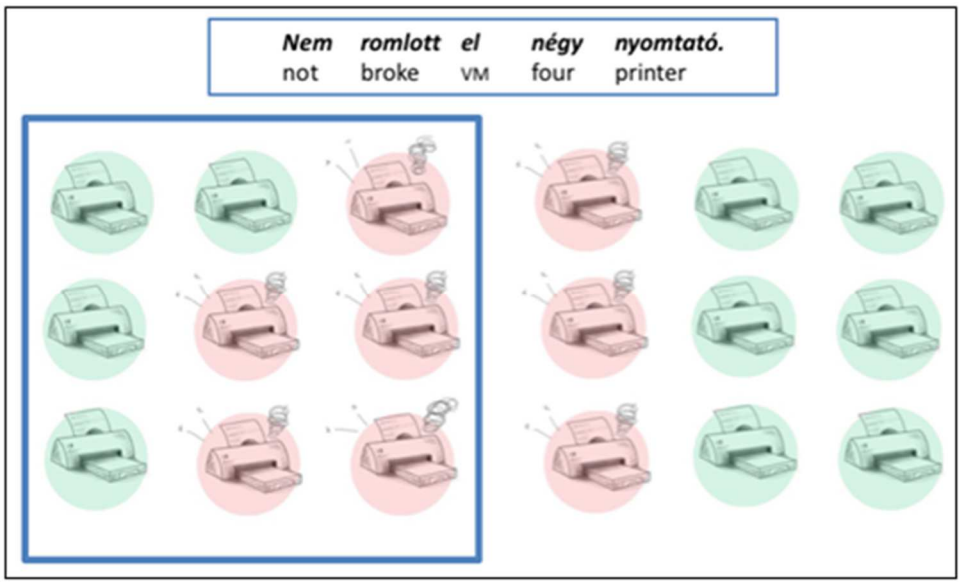

Figure 15. Sample of the target sentences which contained negative sentences

As well as in Experiment 1, the sentences were recorded with a head-mounted microphone in a soundproof room. There was a training session before the experimental items. During this session, the experimental assistant was available for any clarification questions. The disambiguating pictures were presented in a pseudo-random order. All readings occurred four times. Furthermore, it was pseudo-randomized as well whether the right or the left picture was framed. The target conditions had five, while the controls had two lexicalizations. 6 additional filler sentences were included to balance the design which yields 120 token per person:

(108) a. Critical items

5(lexicalizations) × 2(Scope readings) × 4(recordings) = 40

b. Control items

2(type 1/2) × 2(lexicalizations) × 2(readings) × 4(recordings) = 32

c. Filler items

6(lexicalizations) × 2(readings) × 4(recordings) = 48

DOI: 10.15774/PPKE.BTK.2020.021

4.1.2.3 *Results and analysis*

As it was reported in Section 4.1.1.3, I annotated the sound files automatically using ProsodyLab Aligner (Kyle et al. 2011) and investigated the first syllables' nucleus vowel of all content words in the given sentence. I extracted the following data with Praat (Boersma 2001): the F0 maxima and minima, their position, the pitch range, the intensity and the duration of the vowels of the first syllables. Vowel factor: Neg/V/VM/Num/N:

(109) *Nem romlott el négy nyomtató*
not broke VM four printer
[Neg][V] [VM][Num] [N]

The F0 values were transformed into semi tones by speakers (using 20Hz as a base value). I calculated the F0 slope using Hz values and subtracting F0 minima from F0 maxima (= F0 range (Hz)) and F0 minima time point from F0 maxima time point (= F0 slope duration (s)); finally, I divided the F0 range by the F0 slope duration which yielded the F0 slope (Hz/s). I took only the negative data into consideration, since those are the relevant ones, expected to contain falling tones.

The target conditions, the F0 max semitone values were analyzed following a model containing the Scope and the Vowel as fixed factors with an interaction between them. Subjects and items were considered as random factors without random slopes. The model found the main effect of the Scope factor ($\chi^2(1)=22.11$; $p<0.001$) as well as the main effect of the Vowels ($\chi^2(4)=806$; $p<0.001$) and an interaction between the fixed factors ($\chi^2(4)=9.58$; $p=0.048$). The post hoc tests contrasting the lsmeans of the data with Tukey correction showed that the vowels of the verbal modifier (*t-ratio*=2.88; $p=0.004$), the numeral (*t-ratio*=3.368; $p<0.001$) and the noun (*t-ratio*=3.079; $p=0.002$) differ from each other in the two scopal readings.

Analyzing duration using the same model mentioned above, a strong main effect of the Scope factor ($\chi^2(1)=31.9$; $p<0.001$) was observed as well as the main effect of the Vowel factor ($\chi^2(4)>1000$; $p<0.001$) and an interaction between the fixed factors ($\chi^2(4)=83.35$; $p<0.001$). The post hoc test revealed that the vowel of the numeral (*t-ratio*=9.94; $p<0.0001$) and the noun (*t-ratio*=3.33; $p<0.001$) differ significantly with respect to the two scope reading realizations.

The main effect of the Scope factor was found in the case of the F0 slope ($\chi^2=5$; $p<0.03$) as well. This effect originates from the significant difference between the two realizations of the noun (*t-ratio*=-2.59; $p=0.01$).

DOI: 10.15774/PPKE.BTK.2020.021

Finally, the analysis of the intensity data (dB) did not reveal any main effect of the Scope factor ($\chi^2(1)=0.21$, $p=0.65$), although a strong interaction between the fixed factors ($\chi^2(1)=19.29$, $p<0.0001$) was detected. The most parsimonious model contained the interaction between the fixed factors and the random factors, Item with Vowel as a random slope, and Subject with a random slope that has the fixed factors with interaction. The *post hoc test* revealed the source of interaction as the differences in realization of the following Vowel conditions in the two scope readings: negative particle (*z-ratio* 2.28, $p=0.02$); verbal modifier (*z-ratio* -2.17, $p=0.03$); numeral (*z-ratio* -3.97, $p<0.001$). The results and the analysis of the Control conditions have already been described in Section 4.1.1.3.

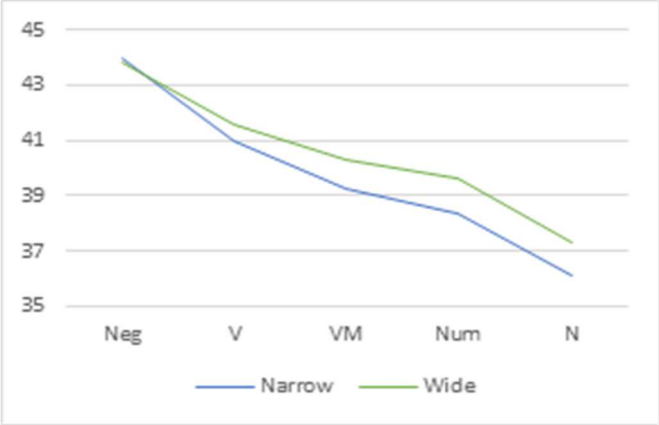

Figure 16. F0 maxima (st)

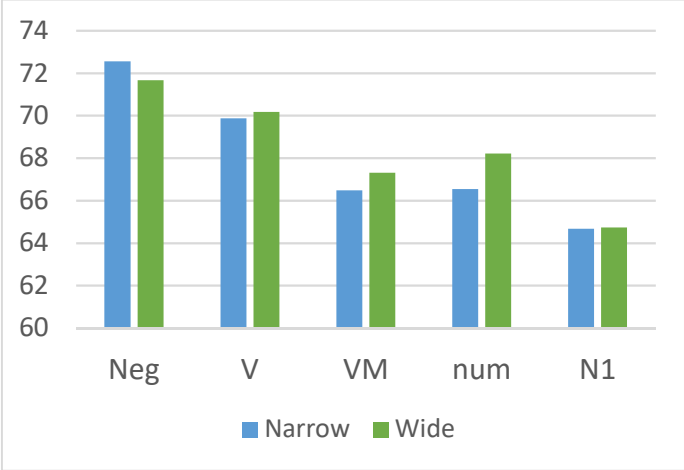

Figure 17. Intensity (dB)

DOI: 10.15774/PPKE.BTK.2020.021

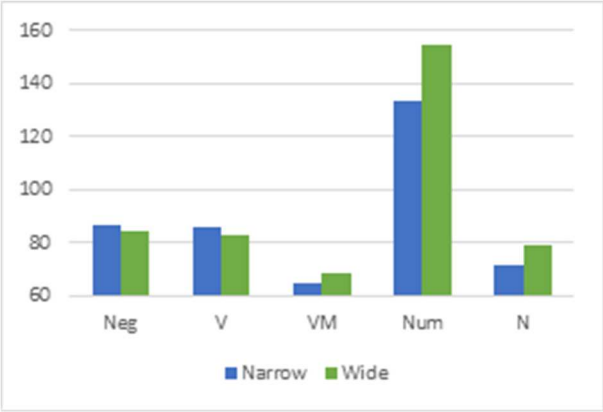

Figure 18. Duration (ms)

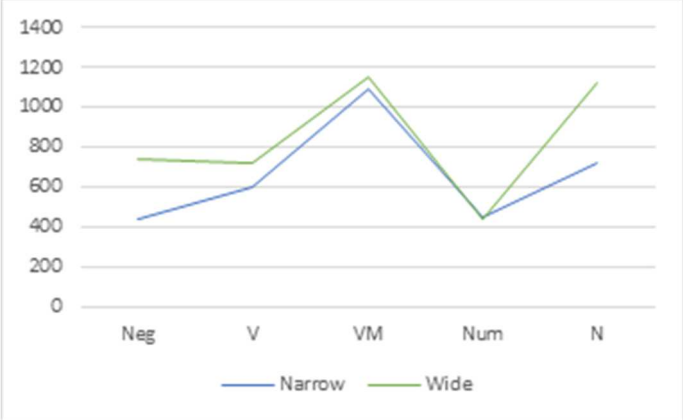

Figure 19. F0 Slope (absolute value, Hz/s)

4.1.2.4 *Interim summary*

In this experiment I tested the scope interaction between the negative particle and an indefinite bare numeral without controlling the information structure. The participants and the control conditions were the same as in Experiment 1. The results clearly demonstrate that the participants differentiated between the two scope readings unlike in the case of doubly quantified sentences in Experiment 1. Three of the investigated factors were affected, namely the F0 maxima, F0 slope and duration. The participants expressed the scope differences in F0 maxima most of all, since not only the first accented vowel of the noun but the numeral and even the verbal particle were affected. The participants used different F0 slopes on the noun, while they realized the first accented vowel of the numeral and of the noun in different length concerning the two scopal readings.

Comparing this data to the results of the Control conditions described in Section 4.1.1.3 and 4.1.1.4, I can assume that in the case of negative sentences encompassing an indefinite bare

DOI: 10.15774/PPKE.BTK.2020.021

numeral, the two possible logical readings have different prosodic realizations. These findings are clearly in line with Baltazani's results in Greek. Recalling her analysis of such sentences, I can argue that the participants assigned different information structures to the two different scope readings. This became apparent in the fact that the two information structures were reflected in prosody. The two possible questions under discussion could be formulated as (110.a) and (111.a).

(110) a. Did four printers break down? Linear scope reading: Neg > NumP

b. *Nem romlott el négy nyomtató*
not broke VM four printer
'No, four printers did not break down, only two did.'

(111) a. How many printers did not break down? Inverse scope reading: Neg < NumP

b. *Nem romlott el négy nyomtató*
not broke VM four printer
'There were four printers which did not break down.'

In the linear scope reading, the negation is not part of the question under discussion, hence it has the status of new information. The rest of the sentence counts as given as for information structural status. On the other hand, in the case of the inverse scope interpretation, the negation is part of the question under discussion, hence it is marked as given, while the quantity of the printers broken down is new and – probably – focussed in the target sentence. These two different information structures are clearly reflected in the realizations of the target sentences.

4.1.3 Scope interaction between Neg vs. QP – Experiment 3A

The experiment presented in this section investigated negative sentences containing a quantified noun phrase: *több mint három nyomtató* ('more than three printers'). This quantified expression may take distributive inverse scope from a post-verbal position, and it is an upward monotonic quantifier just like *every*. A further advantage of *more than n* is that it does not change in negative sentences unlike *mindegyik* which is sensitive for negation.

As Experiment 1 showed, the two scope readings of the universal quantifier is not expressed in prosody, while in the case of negative sentences containing a bare numeral indefinite, the speakers differentiated between the two possible scopal readings. Although in the latter case I

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concluded that it was probably because the two information structures were reflected in prosody and not because of the scope reading *per se* has a direct effect on prosody. In this section I take a closer look at the scope relation of the negative particle and a quantified phrase. I expected that the two scopal readings are expressed in the prosody as it was described in Section 4.1. Unlike in the former experiments, I used textual disambiguation, since the quantified NP and the negation formed a complex scenario which could be comprehended better by means of paraphrases.

4.1.3.1 *Specific research questions*

Considering Baltazani's and the results of Experiment 2, I investigated the research question formulated in (112) below:

(112) Do Hungarian speakers differentiate between the two available
scope readings of negative sentences containing a quantified expression
by means of distinct prosodic forms?

Similarly to Experiment 2, I expected the speakers to realize the two scope readings in different prosodic forms just like in Experiment 2 since the QUDs can be recovered in negative sentences even in the absence of an explicit context.

4.1.3.2 *Materials*

One of the target sentences is given in (113), while the two paraphrases corresponding to the two scopal readings are presented in (113.a) and (113.b).

(113) *Nem romlott el több mint három nyomtató.*
no broke VM more than three printers
'No more than three printers broke down.'

a. Linear scope paraphrase
Nem volt háromnál több olyan nyomtató,
no were three more such printer
ami el-romlott (legfeljebb három romlott el).

DOI: 10.15774/PPKE.BTK.2020.021

which VM-broke (at.most three broke VM)
'No more than three printers broke down.'

b. Inverse scope paraphrase
Háromnál több olyan nyomtató volt,
three more such printer was
ami nem romlott el (hanem működött tovább).
which no broke VM (but functioned further)
'There were more than three printers which did not break down.'

I implemented two types of control stimuli to check whether the participants understand their task clearly. Control type 1 (114) contained sentences which have only the so-called rising–fall B-accent (contrastive) intonation (see Section 2.3.3); pronounced in any other way these sentences would not be acceptable (no proper PF would be assigned to them).

(114) a. *Nem ébredt fel, csak három óvodás.*
not woke VM only three child
'Only three children woke up'
b. Only three children woke up (the others were asleep).

The other type of the control stimuli (Control type 2, (115)) resemble the controls of Experiment 1 and 2. The two prosodic realizations of (115) differ from the focus accent on the determiner or on the noun. For more details on the determiner *egy* (a/one) see section 4.1.1.2.

(115) a. *Nem egy rendőr érkezett ki a helyszínre, hanem egy mentős.*
not a/one policeman arrived VM the spot but a/one ambulanceman
'Not a policeman arrived on the spot but an ambulance man'

b. *Nem egy rendőr érkezett ki a helyszínre, ahogy várható lett volna,*
not a/one policeman arrived VM the spot as expected be would
hanem egy mentős (a legközelebbi baleseti kórházból).
but an ambulanceman (the nearest emergency hospital.from)
'Not a policeman arrived on the spot as it would have been expected
but an ambulance man (from the nearest hospital)'

DOI: 10.15774/PPKE.BTK.2020.021

The paraphrase was displayed at the top of the screen in black letters, while the critical sentence appeared in the middle of the screen in light green letters. The task of the participants was to comprehend the paraphrase first and then read the target sentence aloud as naturally as they can. They were allowed to repeat the sentence if they judged their own realization unnatural or faulty.

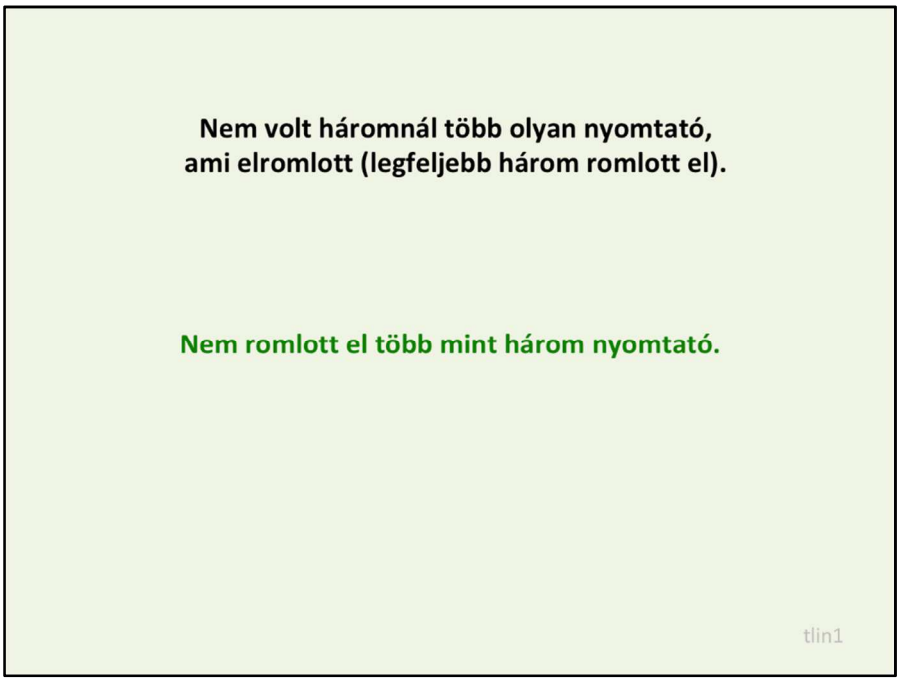

Figure 20. Sample stimuli of Experiment 3

As well as in Experiment 1 and 2, the sentences were recorded with a head-mounted microphone in a soundproof room. There was a training session before the experimental items. During this session, the experimental assistant was available for any clarification questions. The disambiguating pictures were presented in individually pseudo-randomized order for each participant. Each stimulus occurred four times yielding four recordings per item. The 8 native speakers participating in this experiment read out 80 tokens. The design of the experiment is displayed in (116).

(116) a. Critical items

5(lexicalizations) × 2(Scope readings) × 4(recordings) = 40

b. Control

4(lexicalizations) × 1(reading) × 4(recordings) = 16

DOI: 10.15774/PPKE.BTK.2020.021

2(lexicalizations) × 1(reading) × 4(recordings) = 8

c. Filler items

4(lexicalizations) × 1(reading) × 4(recordings) = 16

4.1.3.3 *Results and analysis*

As in the case of the two preceding experiments, I analyzed the vowels of the first syllables, yielding 7 levels for the Vowel factor given in (117):

(117)

Nem	*romlott*	*el*	*több*	*mint*	*három*	*nyomtató*
not	broke	Vm	more	than	three	printer
[Neg]	[V]	[VM]	[Q]	[Prt]	[Num]	[N]

Starting the analysis with the F0 maxima (in semitones), the considered linear mixed effects model – after the backward model elimination procedure – contained the Scope and Vowel as fixed factors with interaction between them, and item (without random slope) and subject (with both fixed factors as random slopes but no interaction between them) as random factors. No main effect of the Scope factor was detected ($\chi^2(1)=0.29$; $p=0.59$), while the Vowel factor had a significant main effect ($\chi^2(6)=157.12$; $p<0.001$), and crucially, there was an interaction between the two fixed factors ($\chi^2(6)=20.5$; $p<0.01$). The *post hoc* test revealed that there was a significant difference between the linear and the inverse scope realization of the verbal modifier (*t-ratio*(1)=-2.98; $p=0.004$).

In the case of F0 slope, first I investigated the ratio of the rising and falling tones. The logistic regression model contained the fixed factors with interaction and the item and subject (with vowel as random slope) as random factors. No main effect of Scope ($\chi^2(1)=0.07$; $p=0.79$) was detected, but there was a significant main effect of the Vowel factor ($\chi^2(6)=40.25$; $p<0.001$) and the interaction was significant ($\chi^2(6)=21.12$; $p<0.01$) as well. Post hoc test showed a tendency between the two scope realization of the negative particle (*t-ratio*(349)=-1.71; $p=0.087$), a significant difference in the verbal modifier (*t-ratio*(349)=2.40; $p=0.017$) and in the quantifier (*t-ratio*(349)=-3.085; $p=0.002$). Taking a closer look at the F0 slopes, the model that investigated the data detected no main effect of the Scope factor ($\chi^2(1)<0.01$; $p=0.95$) a significant effect of Vowel factor ($\chi^2(6)=22.4$; $p<0.01$) and no interaction ($\chi^2(6)=9.35$; $p=0.15$). *Post hoc* test revealed a significant difference between the two realizations of the noun (*t-ratio*(451)=1.98; $p=0.048$).

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Turning to the duration data, the model contained the two fixed factors with an interaction, and the Item (Vowel as random slope) and Subject (the fixed factors with interaction as random slope) as random factors. The model detected no main effect of the Scope factor ($\chi^2(1)<0.01$; $p=0.94$), but found a main effect with respect to the Vowel factor ($\chi^2(6)>1000$; $p<0.001$), while the interaction ($\chi^2(6)=9$; $p=0.17$) was not significant. The post hoc test revealed a difference in length of the first vowel of the quantifier (*t-ratio*$(8.91)=2.31$; $p=0.47$) in the case of the two scope readings.

Finally, in the case of intensity, the most parsimonious model contained the fixed factors with an interaction and the random factors with the Vowel as a random slope in both cases. The analysis did not reveal an effect of the Scope ($\chi^2(1)<2.54$; $p=0.11$), neither could interaction be detected between the two fixed factors ($\chi^2(6)=3.47$; $p=0.75$). Naturally, the Vowel factor had a main effect ($\chi^2(6)=179.65$; $p<0.001$).

Figure 21. F0 maxima (st)

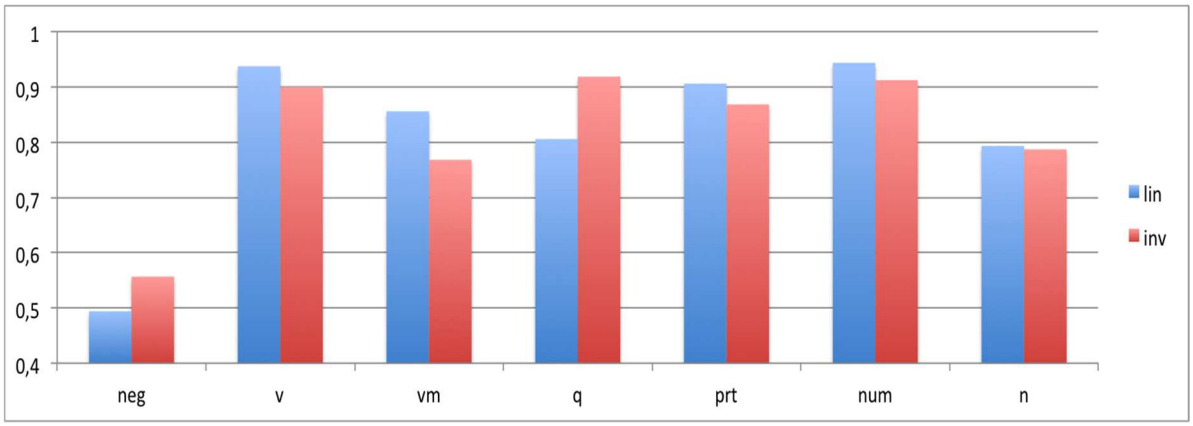

Figure 22. F0 slope: The proportion of the falling tones

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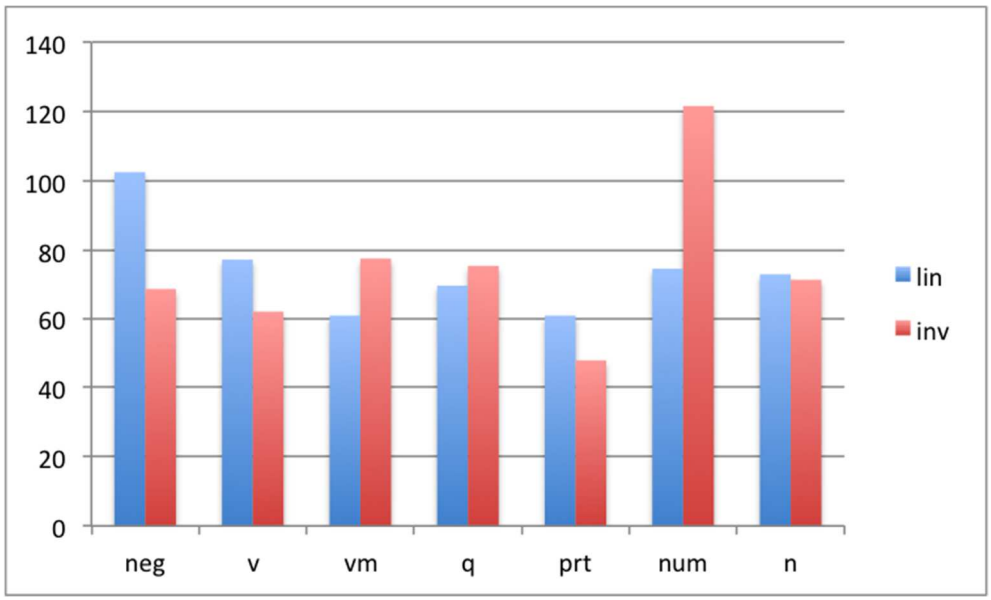

Figure 23. Duration (ms)

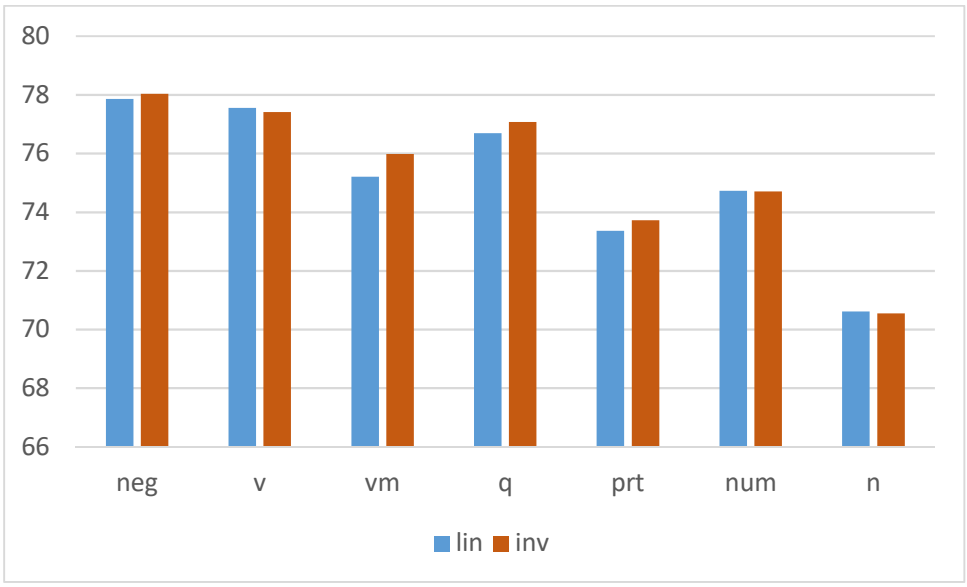

Figure 24. Intensity (dB)

4.1.3.4 *Summary and discussion*

Even if the results of this experiment are not as straightforward as the results of Experiment 2, there are nonetheless clear tendencies that shed light on the fundamental similarities between the two experiments. First of all, the three crucial dependent variable types, namely the F0 max, the F0 slope and the duration, were affected in both experiments. Recall, that in the case of Experiment 2, the F0 max realization of VM, Num and N differed in the two readings, while in Experiment 3, the two readings of VM also differed concerning the F0 maximum. The two

DOI: 10.15774/PPKE.BTK.2020.021

realizations of Num and N differed with respect to the duration in Experiment 2, and Num was also affected in Experiment 3. Last but not least, regarding the F0 slope, the N was realized differently with respect to the two readings in both experiments as it is summarized in Table 3.

Exp2

	[Neg]	[V]	[VM]	[–]	[–]	[Num]	[N]
F0			*			*	*
Duration						*	*
F0 Slope							*

Exp3

	[Neg]	[V]	[VM]	[Q]	[Prt]	[Num]	[N]
F0			*				
Duration						*	
F0 Slope							*

Table 3. The affected vowels (marked with asterisk) and the dependent variables

However, it has to be underlined that in Experiment 3, only the *post hoc* tests revealed such differences, and the Scope factor did not show any main effects. Bearing these facts in mind, I approach these findings with caution but still they can be revealing even with this smaller dataset: data from 18 participants were analysed in Experiment 2, while 8 participants' data entered the statistical analysis in Experiment 3. I can hypothesise that such a tendency could occur even more vividly in a bigger data set.

The other factor that could affect the data of Experiment 3 is the complexity of the scenario that the target condition depicted. While in Experiment 2 the numeral expression in the inverse scope reading – probably because of the QUD – was associated with focus status, it got an "exactly four" meaning (c.f. É. Kiss 2010b)[24]. This fact could cause the clearer prosodic distinction in Experiment 2. On the other hand, in Experiment 3, even the inverse wide scope reading of the quantified phrase remained open for calculation, since in the proper scenario *at least* 4 machines did not break down – as the paraphrase explicitly indicated. This openness of the condition could be reflected in a less concrete prosodic realization of the two scopal readings.

[24] Even the picture stimulus depicted an 'exactly four' reading of this scenario.

DOI: 10.15774/PPKE.BTK.2020.021

Finally, a crucial factor has been revealed concerning the falling–rising tone proportion. The participants realized not only the inverse reading in two intonation phrases – as it was expected – but even the linear readings as well. The participants differentiated between the two readings by means of inserting a boundary tone either after the Q, or after the VM, intending the linear and wide scope readings, respectively, as presented in (118) and (119), and Figure 24 and 25.

(118) ([Neg] [V] [VM] [Q] **H%**)$_{IP1}$ ([Prt] [Num] [N])$_{IP2}$

(119) ([Neg] [V] [VM] **H%**)$_{IP1}$ ([Q] [Prt] [Num] [N])$_{IP2}$

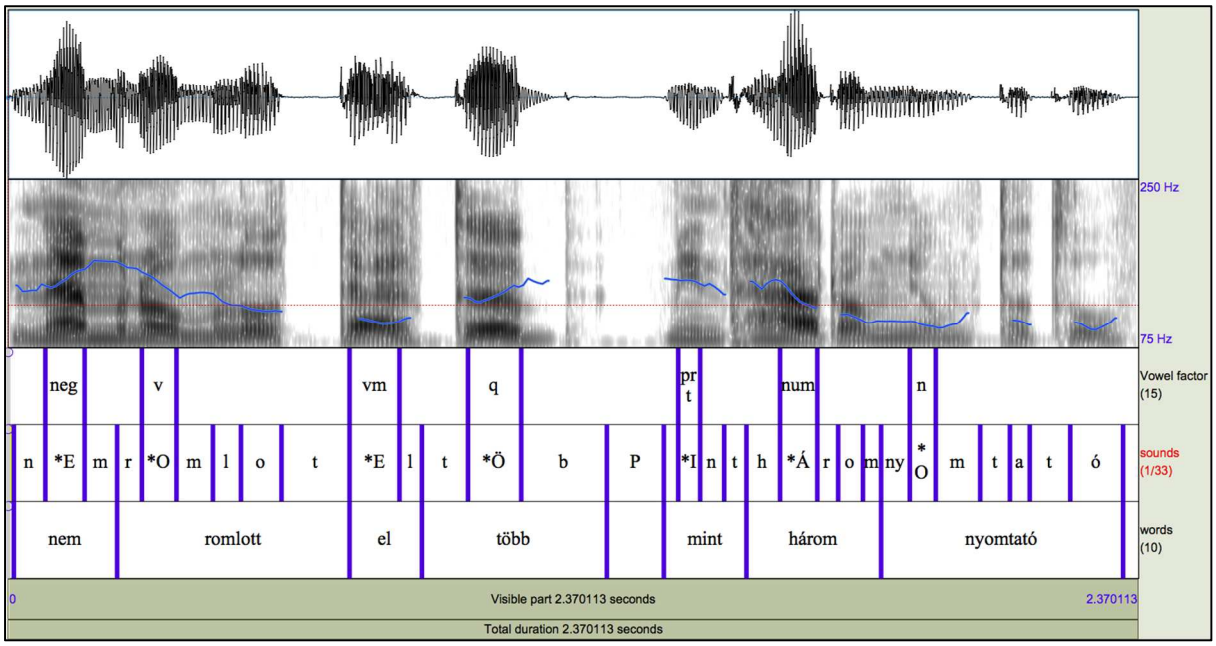

Figure 24. The realization of the Linear Scope reading (Praat visualization)

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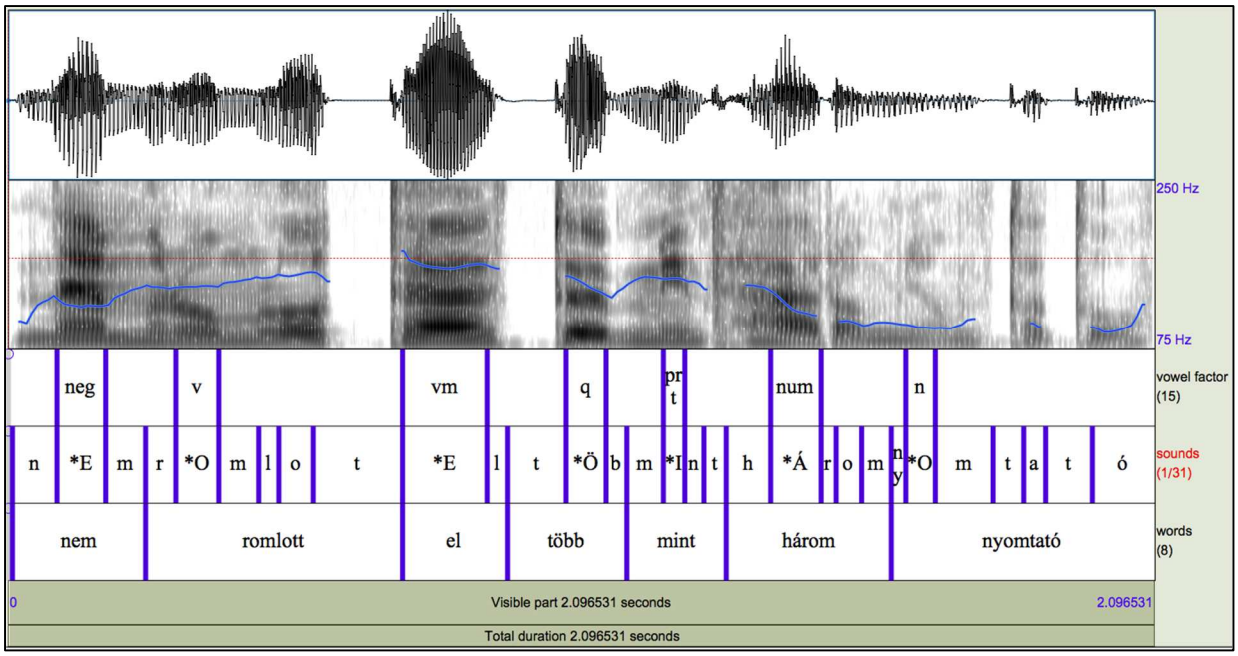

Figure 25. The realization of the Inverse Scope reading (Praat visualization)

These results seems to be in line with Hunyadi's (1999, 2002) theory, since in the case of the linear scope reading, the quantifier is in the logical scope of the negation, hence the quantifier is in the IP of the negative particle, in the prosodic realization (118). On the other hand, in the case of inverse scope, the quantifier takes scope over the negative particle, and the quantifier forms a different IP in prosody (119). However, considering Baltazani's (2002a,b), Gyuris and Jackson's (2018) studies and the former results, I argue that this phenomenon is attested not because of the different logical scope interpretations but because of the different information structures.

All in all, similarly to the conclusion of Experiment 2, I argue that the participants assigned different information structures to the two different scope readings which were reflected in prosody. The two possible questions under discussion could be formulated as in (120.a) and (121.a).

(120) a. Did more than three printers break down? Linear scope reading: Neg > QP

b. *Nem romlott el több mint három nyomtató*
not broke VM more than three printer
'No, no more than three printers broke down.'

DOI: 10.15774/PPKE.BTK.2020.021

(121) a. How many printers did not break down? Inverse scope reading: Neg < QP

b. *Nem romlott el több mint három nyomtató*
not broke VM more than three printer
'There were more than three printers which did not break down.'

Again, just like in the case of Experiment 2, the negation is not part of the Question Under Discussion in the linear scope reading, hence it has new information structural status, while the rest of the sentence qualifies as given information. The inverse scope interpretation is understood as the negation is part of the QUD, hence it is marked as given, while the quantity of the printers broken down is new and – probably – focused in the target sentence. As well as in the case of Experiment 2, these two distinct information structures are clearly reflected in the realizations of the target sentences.

4.2 A supplementary acceptability judgment study: Neg vs. QP

This short section presents a minor study which investigated the material of Experiment 3A with an acceptability judgment paradigm (Experiment 3B). The rationale behind this experiment is testing the acceptability of the inverse scope reading of the target sentences. It is crucial to have such data to rely on, since in the case of the production experiment if the participant did not accept the intended reading, they could assign unnatural prosody to the clause. Because of this reason, the acceptability judgment task preceded the production study. I report the experiments in this order for the sake of not breaking the enumeration of the production studies. No difference was found in judgments between the two scopal readings on a 7-point Likert scale. Thus I argue that the inverse paraphrases I provided the participants with in Experiment 3B are acceptable for a production experiment.

4.2.1 Research question

The research question of this supplementary experiment is formulated below.

(122) Do native speakers judge the two scope readings of the sentence type given in (122) differently?

DOI: 10.15774/PPKE.BTK.2020.021

It is well-known from the literature that inverse scope readings are somehow degraded compared to the linear scope readings because of processing cost, supposedly (see Section 2.1). Hence I used control items ((125) and (126)) to be able to differentiate between the real grammatical differences from the confounding processing load. On the other hand, I expected some extra load on the target sentences, since they encompass rather complex scope relations.

4.2.2 Materials

I used the same target stimuli that I investigated in Experiment 3A (repeated in (123)) accompanied with acceptable and unacceptable control stimuli, given in (124.a) and (124.b), respectively.

(123) Sample Target stimuli:

Nem romlott el több mint három nyomtató
not broke VM more than three printer
'No more than three printers broke down.'

(124) a. Linear scope paraphrase

Nem volt háromnál több olyan nyomtató,
no were three more such printer
ami el-romlott (legfeljebb három romlott el).
which VM-broke (at.most three broke VM)
'No more than three printers broke down.'

b. Inverse scope paraphrase

Háromnál több olyan nyomtató volt,
three more such printer was
ami nem romlott el (hanem működött tovább).
which no broke VM (but functioned further)
'There were more than three printers which did not break down.'

In (125) I present a sample of the acceptable control stimuli, while (126) represents the unacceptable counterpart:

DOI: 10.15774/PPKE.BTK.2020.021

(125) a. *Nem ébredt fel, cask három óvodás.*
not woke VM only three child
'Only three children woke up'
b. Paraphrase
'Only three children woke up (the others were asleep)'

(126) a. *Csak kevés vendég nem jött el.*
only few guest not came VM
'Only a few guests did not come'
b. Paraphrase
'Hardly any guests came (the others stayed home)'

The procedure was as follows. First the paraphrase appeared at the top of the screen in black font color. After five seconds the target sentences occurred in the middle of the screen, displayed in light green. After additional five seconds, the 7-point scale popped up at the bottom of the screen. The paraphrase and the target stimuli remained displayed until the participant made a judgment clicking on one of the points of the scale. A training procedure preceded the target trials. There were three examples for the possible scope readings and there were additional training trials which had the same procedure, although in this session the participants got feedback on their judgments. Two comprehension questions were inserted into the experiment, one at the end of the training session, and one at the very end of the experiments, querying whether the task is clear for the participants. An additional text box was available for feedback which the participants could possibly share with me. 26 speakers enrolled in this experiment: 12 men and 14 women, with the mean age of 38.5y. There were two pseudo-randomized orders presented, having 5 target sentences with Linear and other 5 with Inverse scope reading. There were 5 acceptable and 5 unacceptable fillers per list, and additional 2×5 filler sentences were added to the list; (127) shows the design of the experiment:

(127) (2×5 target sentences) + (2×5 control sentences) + (2×5 filler sentences) = 30 tokens.

DOI: 10.15774/PPKE.BTK.2020.021

4.2.3 Results and analysis

First, I transformed the raw data into standardized *z*-score by subjects[25]. I excluded two of the subjects, since both of them judged the unacceptable control condition more acceptable than the average of their all judgments.

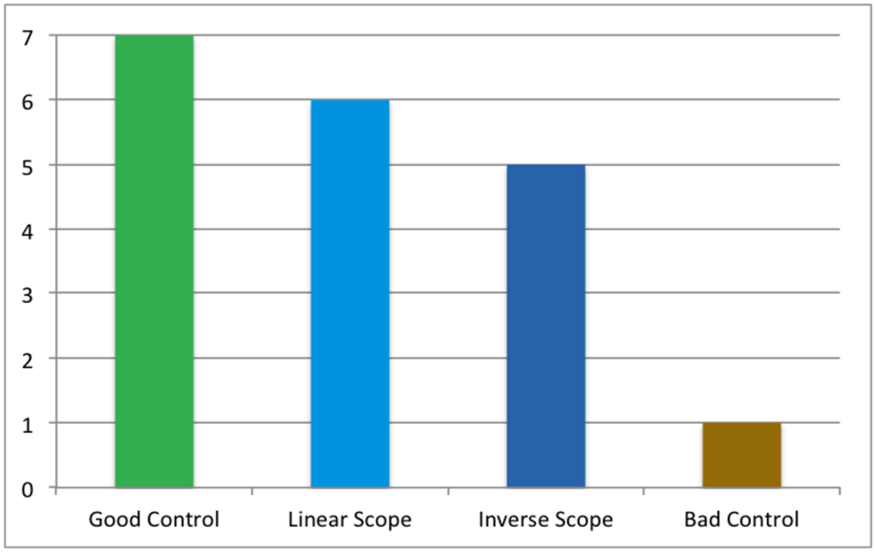

Figure 26. The median values of the raw data per conditions[26]

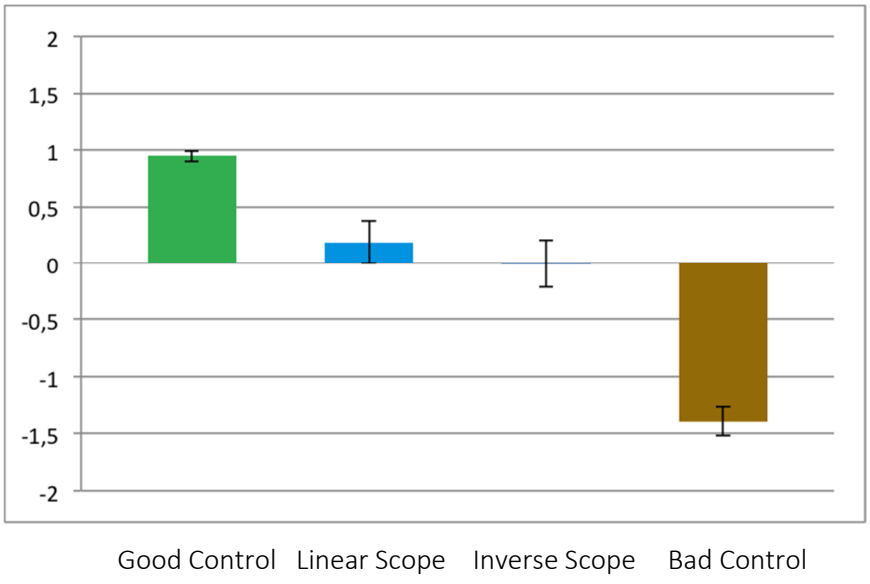

Figure 27. The mean values of the *z*-score transformed data (+/- standard error)

[25] I am treating summed Likert scale data obtained from the numerical judgment scale used in the experiment as interval scale (Carifio and Perla 2007, Schütze and Sprouse 2013). *Z*-scores are standardized scores corresponding to the number of standard deviations that a given raw score is above or below the mean (which is represented by z=0). I estimated means and standard deviations for each subject based on the responses across all test items (including fillers).

[26] Note that the lowest point on the scale was 1, I display point 0 for the sake of visibility of the unacceptable condition.

DOI: 10.15774/PPKE.BTK.2020.021

The first model selection contained all of the four conditions, namely the Acceptable Control, the Unacceptable Control, the Linear Scope and the Inverse Scope. I assigned backward elimination of the linear mixed effects models based on the *z*-score data. The chosen model contained the type of the stimuli as the only factor, with four levels respect to the four target conditions. The model also encompassed the Item as random factor, without random slope, and the Subject as random factor having the fixed factors as random slope. The model detected a strong significant main effect ($\chi^2(3)=1059$; $p<0.0001$) of the investigated factor. The *post hoc* lsmeans comparisons revealed no difference between the Linear and Inverse Scope conditions (*t-ratio*(23)=0.87; $p=0.82$). However, there were significant differences found among the Acceptable conditions and the other three conditions: Acceptable–Linear (*t-ratio*(22.27)=4.83; $p<0.001$); Acceptable–Inverse (*t-ratio*(22)=6.58; $p<0.0001$); Acceptable–Unacceptable (*t-ratio*(12.41)=28.87; $p<0.0001$). Similarly, the Unacceptable condition significantly differed from the other three: Unacceptable–Linear (*t-ratio*(21.96)=11; $p<0.0001$) and Unacceptable–Inverse (*t-ratio*(22.57)=7.68; $p<0.0001$). For the sake of a detailed outcome I investigated a smaller model that contained only the two Scope conditions, having the item as random factor, without random slope, and the subject as random factor having the target stimuli as random slope; it revealed no main effect of the factor, as it was highly expected ($\chi^2(1)=0.75$; $p=0.39$).

In this follow-up experiment I tested whether the inverse scope reading of the Neg vs. QP sentences (see (118)) is judged as acceptable as the linear scope reading. The statistical analysis did not find any significant difference between the two scope readings. As the median of the raw data show, the target sentences were judged as quite acceptable. Bearing in mind these two findings I can conclude that the inverse scope paraphrases used in Experiment 3A are acceptable for the native speakers, hence they can utter the linked target sentences naturally.

4.3 Summary

Summarizing the findings of the three production experiments presented in this chapter, first, recall the acquired statistical effects. The scope factor had a clear main effect in the case of Experiment 2 which tested negative sentences. I argued – relying on similar findings described by Baltazani (2002a,b) – that information structure reflected in the two distinct prosodic realizations of the scope readings. In the case of negation I argue that the QUDs are unambiguous. Second, no main effect of scope was found in the case of Experiment 3A. However, post hoc tests revealed tendencies on the same features which expressed the different

DOI: 10.15774/PPKE.BTK.2020.021

scope readings in Experiment 2. I hypothesize that the same underlying mechanisms work in the case of the negative quantified sentences, although there are two possible explanations why the results of Experiment 3A are vaguer than the findings of Experiment 2. First of all, I had a smaller data set; the data of 18 native speakers entered the statistical analysis in Experiment 2, while only 8 speakers participated in Experiment 3A. Because of the smaller dataset, the different individual strategies could more easily mask the underlying effects. However, the statistical analysis still detected tendencies similar to the effect found in Experiment 2 since, crucially, I analyzed the data with sophisticated statistical models which took the item and subject variance into consideration. I assume that investigating a larger dataset would result in similar straightforward findings which were found in Experiment 2. Second, the interpretation of the target sentences in Experiment 3A was much more complex than in Experiment 2. While in the case of Experiment 2, the indefinite bare numeral could be easily interpreted in the case of Inverse scope reading as 'exactly four' — as being focused (c.f. É. Kiss 2010b, and the results of the Control stimuli). In Experiment 3A the interpretations were more complex, hence I could not implement as straightforward disambiguating stimuli as I could in the case of Experiment 2. Although the written paraphrases were judged quite acceptable in Experiment 3B, the complexity of the scenarios depicted in Experiment 3A could mask the underlying mechanisms.

Finally, no main effect of scope was found in Experiment 1 which contained doubly quantified sentences. I hypothesize that just as in Experiment 2 and 3A information structure was reflected in prosody, however it is not clear why the participants did not realize the two scope readings in two prosodic forms. One possible answer could be the availability of two QUDs formulated in (128), just as in the case of the negative sentences, which, however, cannot be distinguished in prosody. Considering both Hunyadi's (1999, 2002) and É. Kiss' (2010) observation on doubly-quantified sentences they assume that if the post-verbal quantifier is stressed (provided both quantifiers are in the same category determined by the Operator Hierarchy in Hunyadi's theory), the sentence is scopally ambiguous. In the case of Experiment 1 the native speakers realized the post-verbal quantifier with an accent in both scope-readings, see Figure 11 (F0 maxima) in Section 4.1.1.3.

(128) a. QUD of linear scope-reading in Experiment 3:

How many singers sang every melody?

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b. QUD of inverse scope-reading in Experiment 3:

How many melodies did four singers sing?

Another possible answer for the null effect found in Experiment 1 is that there is no different QUD available in the case of the tested doubly-quantified sentences (or one of them is understood as more acceptable/natural than the other one), hence considering both readings native speakers realized an answer only to one of the two questions under discussion. There are reasons to believe that the invariant information structure assigned to target sentences is that of a broad focus sentence. First, as pointed out in section 3.1.1 above, target sentences did not contain an aboutness topic. In addition, the data provide evidence that the pre-verbal quantified indefinite NP was not interpreted as a focus either, taking the rest of the sentence as its background. This is supported by the fact that the post-verbal quantificational NP was routinely realized with an accent, with a falling one, as expected. The accentedness of the post-verbal universal quantifier is apparent from the lack of a downstep relation between it and the preceding accented element, namely, the prosodic word composed of the VM and the verb (whose accent is realized on the stressed syllable of the VM). The F0-peak of the VM and the post-verbal quantifier alike is approximately 40 st in both scope conditions. While generally both accented and unaccented lexically stressed syllables may be downstepped from the preceding accent, only accented syllables may be non-downstepped. If participants had interpreted the pre-verbal indefinite as a focus and the post-verbal quantificational noun phrase as part of its background, then the peak of the latter NP would be expected to be lower than the peak of the preceding accented syllable, contrary to fact.

Bearing this null result in mind, in the next chapter I present two experiments in which I controlled information structure to test whether the prosody (in speech production and in speech perception) can express the difference between the two logical readings if the information structure is kept in check.

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5 EXPERIMENT TYPE II – CONTROLLED INFORMATION STRUCTURE

Chapter 4 provided a series of experiments in which target sentences appeared out of context, without controlled information structure. In the case of investigating the scope interaction between two quantifier phrases, I did not find any effect of prosody. On the other hand, in the case of the negative sentences, I concluded that the two prosodic realizations may only reflect information structure rather than scope itself. In this chapter, I study in detail the scope relations of doubly quantified sentences in an information structurally controlled environment. I provided both visual and textual context to the target sentences: on the one hand, the possible scenario linked to the available scope reading was depicted with natural-looking figures and implemented in a diagram; on the other hand, the target sentence was incorporated into a dialogue making clear the information structural status of the crucial scope bearing phrases.

Five experiments were conducted using the above described material. The primary experiment was a production study investigating whether participants express any differences in prosodic realization according to the information structural status or scope reading of the quantifier phrases, or both (Experiment 4A). A follow-up perception experiment checked whether the participants could match the prosodic realization to the intended scope reading (Experiment 4B).

The second type of the experiments was devoted to another main concern of this thesis: the interaction between scope and information structural roles (without the effect of prosody). The main experiment in this section 5.2 scrutinized whether the participants judged the inverse scope reading of the quantifier expressions with focus or given information structural status as acceptable as their linear scope reading counterparts (Experiment 5A). The two supplementary follow-up acceptability judgment studies explored whether or not the relative degradedness of the focus conditions in Experiment 5A is not due to the effect of the non-canonical, post-verbal (hence non-structural, non-identificational; see Section 2.1.4) focus (Experiment 5B), or whether it is due to the complexity of the focus structure involved (Experiment 5C).

Addressing the prime concern of the thesis, the first main section of this chapter presents the production experiment.[27] The second section is devoted to the experiments which shed light on further relations between scope reading and information structural status of the quantifier.[28]

[27] This experiment is reported in Surányi and Turi (2018).
[28] A part of this material has been published in Surányi and Turi (2016, 2017).

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5.1 Production study: QP vs. QP – Experiment 4A

This section investigates whether quantifier scope is expressed prosodically if information structure is kept in check. The production experiment investigates grammatically scope ambiguous doubly quantified sentences with varied focus structures, while lacking a syntactically marked topic or focus. In contrast to the information structural manipulation, which is manifest in the analysis of the acoustic data, the results reveal no prosodic effect of quantifier scope, nor the interaction of scope with information structure. This finding casts doubt on the notion that logical scope can receive direct prosodic expression, and it indirectly corroborates a restrictive view instead that scope interpretation is encoded in prosody only in cases in which it is a free rider on information structure**.**

5.1.1 Specific research questions

In view of the potential effects of information structural roles like topic and focus mentioned above in Chapter 3, the particular question I seek to address in this chapter is whether logical scope itself is expressed in intonation autonomously of contextual effects that may impose a focus or given role on some part of a doubly quantified sentence.

Based on the conclusion reached at the end of the preceding Chapter 1, I investigated the same doubly quantified sentences presented in Experiment 1, in Section 4.1. In these sentences, none of the scope-taking elements (nor of any other element in the sentence) (i) needs to be interpreted as a topic or can easily be assigned topic status even without context (see Section 2.1.4), or (ii) must be interpreted as a focus or can easily be assigned focus status even without context (cf. ‘few students’ in Section 2.2.4 above). Accordingly, the target sentences investigated in the experiment contained no element occupying either a topic or a structural focus position. The sentences were inserted in two carefully controlled contextual settings that served to keep their information structure in check. Specifically, the two types of contexts assigned a narrow focus interpretation to one or the other of the two quantified NPs in the sentence, with the rest of the sentence being given as the background. It was predicted that this information structural difference would be reflected in the prosodic realization of the two quantified NPs in terms of at least some of the acoustic parameters that characterize the distinction between focus versus given background information structure status in Hungarian (see section 2.1.3 and 2.3.4). Furthermore, it was expected that just in case quantifier scope alone systematically affects sentence intonation in a way that is independent of, or additional

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to, information structure, then I would either find that sentences associated with a linear scope interpretation differ in their prosodic realization from corresponding inverse scope sentences with a matched information structure, or at least scope shows an interaction with information structure in shaping the intonation of the sentence. This experiment tested sentence prosody in production. This choice was motivated by previous literature and by the results I found as described in Chapter 4. The influence of prosody and information structure, in particular the potential effect of information structural roles manifested in prosodic prominence relations on scope interpretation in the perception of doubly quantified sentences has already been investigated in Greek and in Hungarian, by Baltazani (2002a;b) and Gyuris & Jackson (2018), respectively (for details, see Section 3.1.1). For the present research, the specific experimental questions are formulated in (EQ.ii) and addressed by a production study.

(EQ) ii. a. Can two sentences that have identical information structures have different (linear or inverse) scope interpretations, and
b. if so, is this reflected in sentence prosody?

5.1.2 Materials

The critical experimental stimuli involved doubly quantified sentences that were used in Experiment 1 as well (see Section 4.1.1.2). Recapping the particularities of these target sentences, they were constructed in such a way as to avoid variation in any of the biasing factors identified in Chapter 3. Each target sentence in the experiment was scopally ambiguous and had the properties illustrated by the example (129) below. The linear and inverse scope readings of (129) are paraphrased in (129.a) and (129.b), respectively.

(129) *Négy* *előadó* *is* *el-énekelte* *mindegyik* *melódiát.*
four singer DIST.PRT VM-sang each melody.ACC
[Num] [N1] [PRT] [VM]–[V] [Q] [N2]
'Four singers sang each melody.'
a. 'There were four singers who sang each melody' four > each (linear)
b. 'Each melody is such that four singers sang it' each > four (inverse)

Note that the paraphrase of the linear scope reading above (129.a) entails the truth of the paraphrase of the inverse scope reading, provided that the same fixed set of singers and

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melodies are involved in the two interpretations. If, however, the sets of melodies paired with the singers on the linear scope reading are disjoint (i.e., if each singer is related to a different set of melodies), then the two scope interpretations are truth-conditionally independent. Indeed, as I spell out below in relation to the visual stimuli, the latter was the case in the critical conditions of the present experiment. Each target sentence was embedded in a dialogue context. The dialogue was made up of two sentences, each of which was uttered by an imagined interlocutor: Speaker A and Speaker B. Each sentence was accompanied by a diagram that represented its intended meaning.

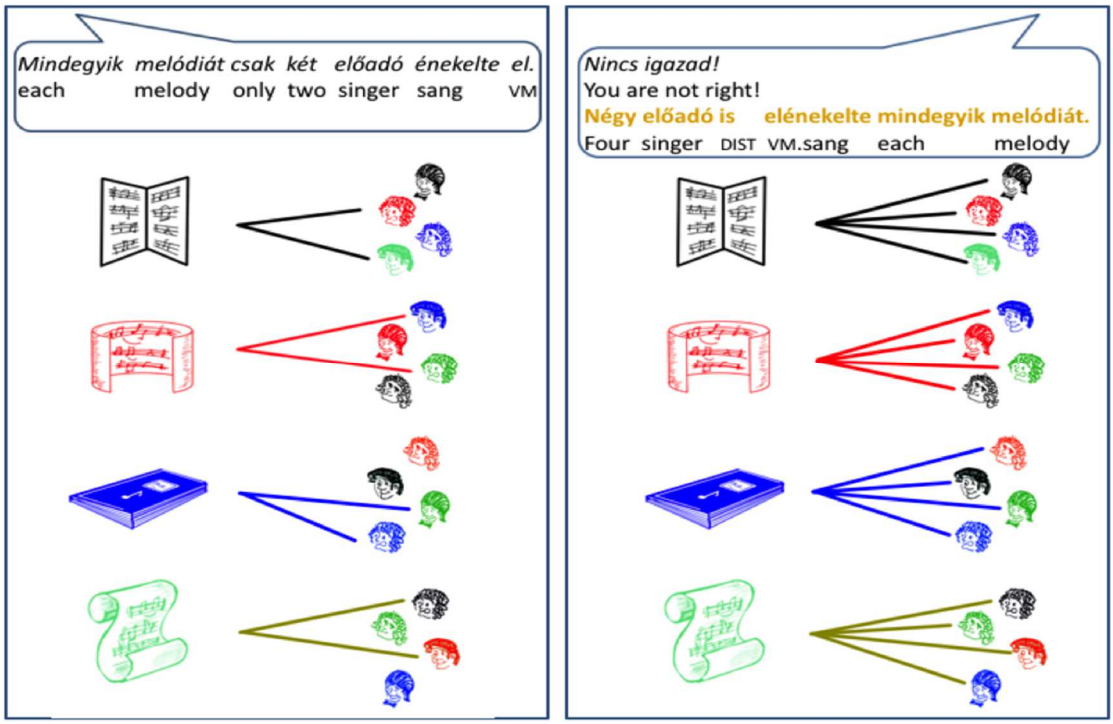

Figure 28. Stimulus exemplifying the Indefinite Focus–Inverse Scope condition

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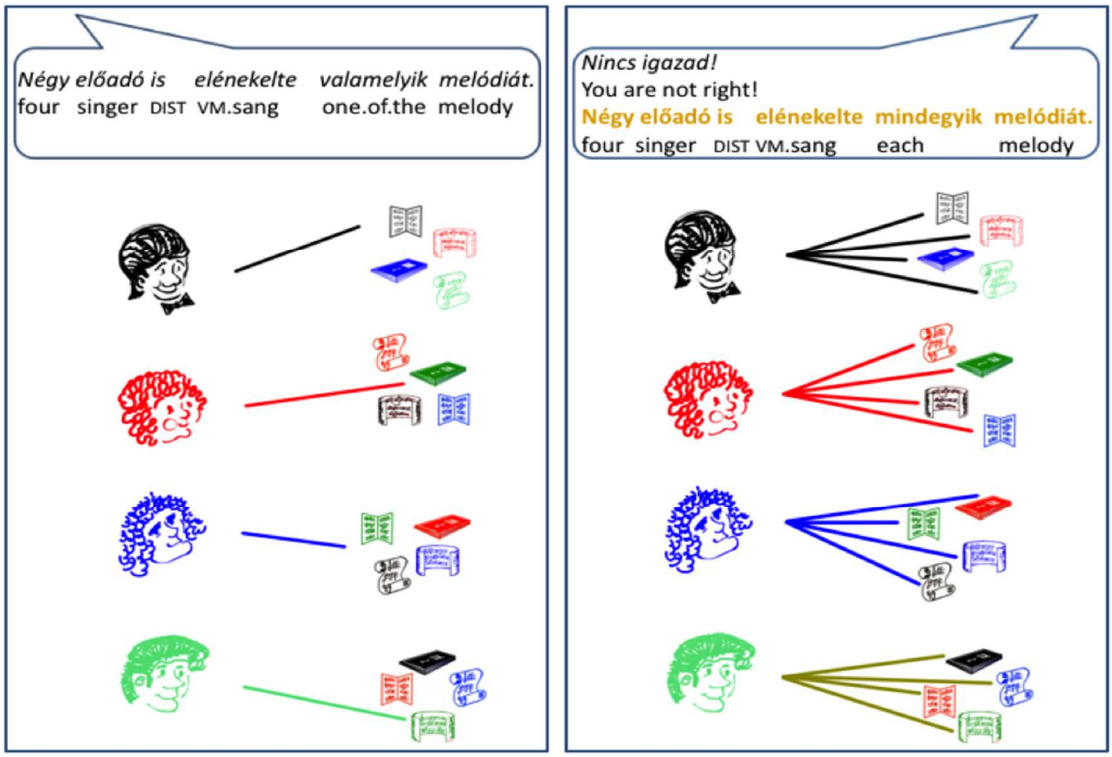

Figure 29. Stimulus exemplifying the Universal Focus–Linear Scope condition

In each trial the target sentence and its context were printed at the top of a display shown to participants on a 22-inch computer screen along with the two images side by side. The images were designed both to fix, and to help participants conceptualize, the intended scopal meanings. Figures 28 and 29 provide a sample of the target displays (with glosses added below the dialogue for convenience). In each diagram the set of figures that corresponded to the phrase with wider scope (Figure 28: the set of melodies, Figure 29: the set of singers) were arranged vertically at the left-hand side, while the sets of figures corresponding to the narrow scope phrase (Figure 28: the sets of singers, Figure 29: the sets of melodies) were consistently arranged along the right edge. Participants were instructed that differences in color and shape represented distinct individuals/objects. The color and spatial position of the figures were varied across the right-hand side sets in order to make sure that these sets were perceived as being disjoint, representing distinct sets of individuals/ objects. Thus, for example in the image representing the inverse scope reading of (129), each one of four melodies is linked to a different set of singers. As a result, in this image there is no singer that is connected to more than one melody, which, as required, is consistent with the inverse scope reading of the sentence and contradicts its surface scope reading. The sentence uttered by Speaker A made a claim about a certain situation. The intended scope relations of Speaker A's context-setting sentence were

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depicted by the diagram on the left hand side, with the claim made by Speaker A printed above it in a speech bubble. Speaker A's interlocutor, Speaker B was aware of what happened in the relevant situation in reality. This was different from what Speaker A claimed, and it was pictured in the right-hand side diagram, along with a speech bubble containing Speaker B's reaction. Speaker B responded to Speaker A's statement by saying "You're wrong" and continued directly with the target sentence, which made the correction. Speaker B's corrective sentence reflected what happened in reality, which was depicted in the right-hand side diagram. Participants were asked to play Speaker B's part by reading out her/his reaction. Speaker A's context-setting statement included two quantified NPs. One of these was identical to one of the two quantified NPs that made up the target sentence in the same trial. The other one crucially differed from the other quantified NP of the target sentence, thereby setting up a contrast, but it quantified over the same sets of (animate or inanimate) individuals. As a result, the quantified NP of the target sentence that contrasted with a quantified NP of Speaker A's context-setting sentence (either the pre-verbal numeral indefinite NP or the post-verbal universally quantified NP) functioned as a contrastive focus. The scope relations depicted by the diagram illustrating Speaker A's statement paralleled the intended scope relations of Speaker B's target sentence, thus, the two key sentences making up the dialogue did not differ in terms of relative scope. To facilitate the intended scope reading of Speaker A's sentence, its form was chosen in such a way that the scope reading depicted below it always corresponded to a linear, surface scope reading. Facilitating the intended scope reading of Speaker A's utterance in this way served to prime the intended – isomorphic – scope reading of the target sentence: Speaker B's corrective target sentence was congruent with Speaker A's context-setting statement only if the scope relations assigned to the former paralleled those assigned to the latter. In sum, the independent factors in this experiment included the information structure and the scope interpretation of target sentences, each of which had two levels. Either the pre-verbal indefinite NP or the post-verbal universally quantified NP was assigned narrow focus status (IS: InFocus/UnFocus), with the rest of the sentence functioning as the background. The targeted scope interpretation was either linear or inverse (SCOPE: Linear/Inverse). Crossing these two factors in a two-by-two design gave rise to four experimental conditions, summarized in Table 4. The dialogues corresponding to these four conditions are illustrated in (130)–(133) below. Items (130)–(133) contain a sample of the context setting questions in the four critical conditions, uttered by Speaker A. The last utterance in (134) is Speaker B's answer containing a target sentence, which is to be read out by the participants – in separate trials – as a reaction to each of the sentences

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in (130)–(133). Figures (28) and (29) above, which accompanied the specific dialogue made up of (28) and (29), exemplify the visual stimuli containing two contrasting diagrams.

SCOPE *IS*	**Indefinite Focus**	**Universal Focus**
Linear	InFocus–Linear	UnFocus–Linear
Iinverse	InFocus–Inverse	UnFocus–Inverse

Table 4. The four experimental conditions

(130) Indefinite Focus – Linear Scope

A: *Csak két előadó énekelte el mindegyik melódiát.*
only two singer sang VM each melody.ACC
'Only two singers sang each melody.'

(131) Indefinite Focus – Inverse Scope

A: *Mindegyik melódiát csak két előadó énekelte el.*
each melody.ACC only two singer sang VM
'Only two singers sang each melody.'

(132) Universal Focus – Linear Scope

A: *Négy előadó is el-énekelte valamelyik melódiát.*
four singer DIST.PRT VM-sang one.of.the melody.ACC
'Four singers sang one of the melodies.'

(133) Universal Focus – Inverse Scope

A: *Csak egy olyan melódia van, amit négy előadó is el-énekelt.*
only one such melody is which four singer DIST.PRT VM-sang
'There is only one melody such that it was sung by four singers.'

(134) B: *Nincsigazad! Négy előadó is el-énekelte mindegyik melódiát.*
is.not right four singer DIST.PRT VM-sang each melody.ACC
'You are wrong. Four singers sang each melody.'

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Participants were instructed to read out Speaker B's part of the dialogues as a corrective reaction to Speaker A's claim in such a way that it matches the situation depicted by the diagram below it (on the right side), which represents what happened in reality, as opposed to the factually incorrect claim made by Speaker A, depicted below Speaker A's utterance (on the left side). Participants were asked to read the dialogue first and carefully inspect the respective diagrams to make sure that they understand the meaning of both Speaker A's and Speaker B's utterance. They were allowed to read out Speaker B's part as many times as they wanted, until they felt their prosodic realization was adequate. In cases in which the target sentence was read out more than once, only the last rendering was included in the analysis. Five different lexicalizations of Speaker B's response were created, each of which was paired up with each of the 4 (= 22) types of contexts set up by Speaker A's utterance. These 20 critical items were complemented with 40 fillers. The 40 fillers fell into 4 different types, with each type having 10 different lexicalizations. Filler items were superficially similar to critical items, and similarly to critical items, they were varied in a balanced way in terms of Speaker B's targeted scope interpretation (which was either linear or inverse). By further analogy to critical items, fillers also differed in a balanced manner with regard to whether the focus was associated with an indefinite NP or a universally quantified NP in them, and also whether this focused NP occupied a pre-verbal or a post-verbal position. Twelve sequences of trials were constructed, each with its own pseudorandomized order. These sequences only differed with regard to the order of the trials that they were made up of. In every sequence each critical item was followed by two filler items, directly preceding the next critical item. Every sequence contained each of the 5 lexicalizations of the 4 critical conditions, as well as each of the 10 lexicalizations of the 4 types of fillers. Every participant was assigned 4 of the 12 sequences in a balanced way. Thus each participant was presented with the very same critical trial four times, once per sequence, yielding four repeated recordings. As summarized below, 80 critical and 160 filler items were recorded per participant; thus for each of the four critical conditions 160 recordings (8 speakers 5 lexicalizations 4 recordings) were made.

(135) a. Critical items

2(SCOPE) × 2(IS) × 5(lexicalizations) × 4(recordings) = 80

b. Filler items

2(SCOPE) × 2(IS) × 10(lexicalizations) × 4(recordings) = 160

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Presenting each lexicalization in all conditions to each participant served to restrict item-related variance and thus increased the likelihood of uncovering any systematic prosodic distinctions that speakers might use to differentiate the interpretations. The recording took place in a soundproof room, using a head-mounted microphone. After the instructions were presented, the experiment started with a short training phase. During the training phase the experimental assistant was available for queries. Participants were allowed to take a short break in between any two of the four sequences. Eight monolingual speakers (mean age = 25, male = 2, female = 6) were recorded, all of them students. They were recruited from Budapest to participate in the experiment, and received financial compensation for their participation.

5.1.3 Results and analysis

As reviewed in Chapter 3, the most common prosodic device that appears to be employed across languages to express logical scope differences is the manipulation of prominence relations, and this is also the means through which Hungarian has been claimed to encode the difference between linear and inverse scope, at least in some sentence types (see Hunyadi 1999; 2002). As well as in the case of experiments presented in Chapter 4, I investigated prosodic prominence relations across different conditions. In particular, the vowel of the first syllable of the numeral and the universal quantifier as well as each content word was analyzed in all target sentences (Vowel = Num/N1/VM/V/Q/N2). The following data of each selected vowel were extracted with the acoustic analysis software Praat (Boersma 2001): values of F0 maxima and minima, the alignment of F0 maxima and minima within the vowel, pitch range, intensity and duration. The F0 values were transformed into semi tones by speaker (using 20Hz as a base value). The F0 ranges and slopes were calculated using Hz values, in each case subtracting the F0 minimum from the F0 maximum (= F0 range (Hz)), and the time point of the F0 minimum from the time point of the F0 maximum (= F0 slope duration (s)). The F0 range was divided by the F0 slope duration, which yielded the value of the F0 slope (Hz/s). Vowels were categorized into those with falling pitch (i.e., vowels in which the F0 minimum followed, rather than preceded the F0 maximum) and those with non-falling pitch. The proportion of falls was calculated for each vowel by dividing the number of falling realizations with the number of all realizations.

I analyzed the parametric data with Linear Mixed Effect Models (using R, R Development Core Team 2018), with the relative scope of the two quantified phrases (SCOPE: Linear or Inverse), the information structure of the sentence (IS: InFocus or UnFocus), and the vowel (Vowel: the first vowel of each content word) as fixed factors, and Subject and Item as random

DOI: 10.15774/PPKE.BTK.2020.021

factors. Model selection was carried out using stepwise backward elimination based on AIC values, starting from the full model with maximal random effect structure, until the most parsimonious convergent model was reached. Each of the selected models included at least random intercepts for both Subject and Item. Beginning with F0 maxima, the most parsimonious model included IS as a fixed factor, interacting with VOWEL. While IS had a significant main effect ($\chi^2(1)=11.44$; $p<0.001$), SCOPE did not ($\chi^2(1)=0.23$; $p=0.63$), and IS and VOWEL exhibited a significant interaction ($\chi^2(5)=16.24$; $p<0.01$). No further interactions were found. A *post hoc* test based on pairwise Tukey comparisons of the two levels of IS within the VOWEL factor revealed a significant difference (*t-ratio*=4.29; $p<0.0001$) in the F0 maximum of the post-verbal universal quantifier word across the two information structures InFocus (M(318)=37.85[6.19]) and UnFocus (M(320)=39.22[6.3]). Mean F0 maxima are depicted in Figure 30. Analyzing the F0 range data, the most parsimonious model contained only VOWEL as a fixed factor, and Item and Subject as random factors without random slopes. No main effect was detected either of SCOPE ($\chi^2(1)<0.001$; $p=0.99$) or of IS ($\chi^2(1)=0.33$; $p=0.57$), and no interaction was found. Figure 31 shows the mean F0 range of the first vowel of each word in the critical sentences across the four conditions.

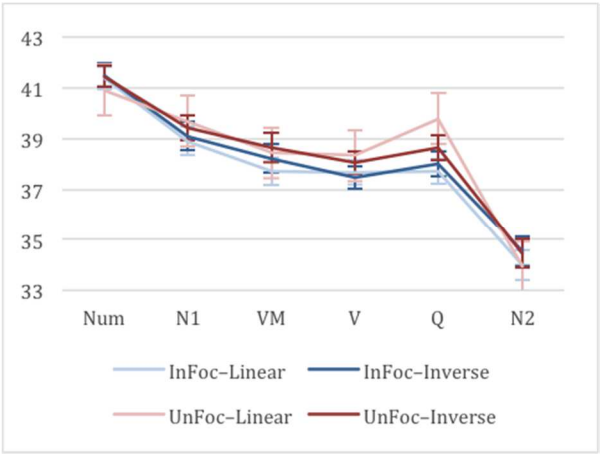

Figure 30. F0 maxima (st; with SE)

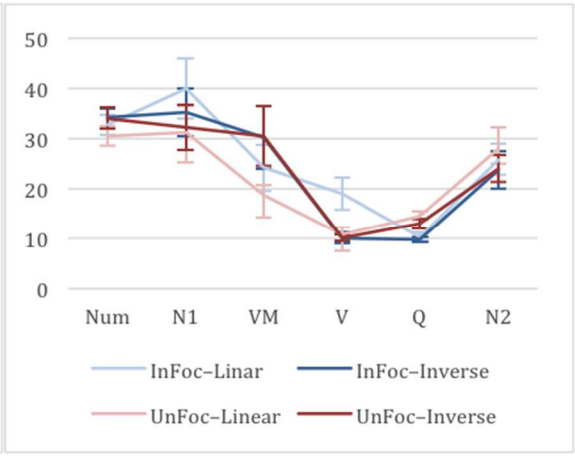

Figure 31. F0 range (st; with SE)

The proportions of falling pitch in vowels were analyzed using logistic regression mixed models. During model selection no significant differences were detected within the VOWELs in the rate of falling realizations either between the two SCOPE readings ($\chi^2(1)=0.03$; $p=0.85$) or between the two levels of IS ($\chi^2(1)=0.30$; $p=0.59$). The most parsimonious model lacked both SCOPE and IS as fixed factors; it only included the VOWEL factor, with no random slopes in Subject and Item. With regard to the mean F0 slope of vowels with falling pitch, which is

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depicted in Figure 32, the most parsimonious model excluded both SCOPE and IS as fixed factors, and only contained VOWEL and an interaction between SCOPE and VOWEL, with the SUBJECT random factor having VOWEL as a random slope. No main effect was found either of IS ($\chi^2(1)=0.68$; $p=0.41$) or of SCOPE ($\chi^2(1)=0.01$; $p=0.91$). IS and SCOPE showed no interaction. In the case of duration the most parsimonious model contained only VOWEL as a fixed factor, and VOWEL was also included as a random slope in the SUBJECT random factor, while ITEM was included without random slopes. Neither IS ($\chi^2(1)<0.001$; $p=0.98$) nor SCOPE ($\chi^2(1)=0.02$; $p=0.88$) had a significant effect on vowel duration, and no interaction was revealed between the fixed factors. Mean vowel durations are depicted in Figure 33.

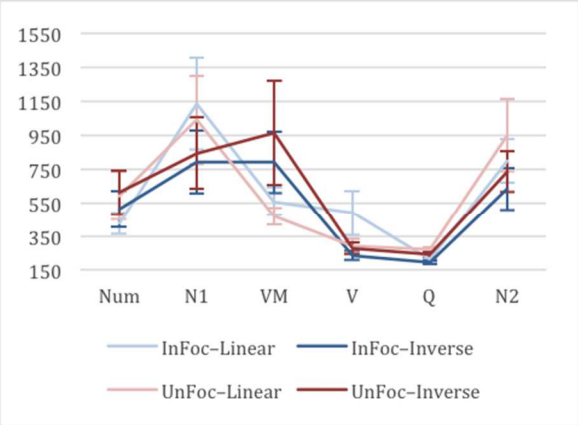

Figure 32. F0 slope (Hz; with SE)

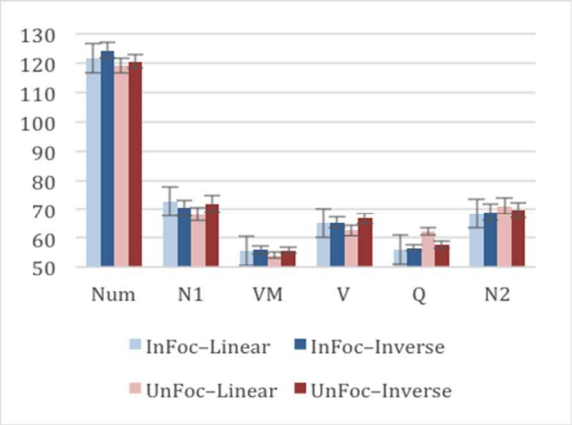

Figure 33. Duration (ms; with SE)

Finally, the analysis of the intensity data revealed no main effect of the SCOPE ($\chi^2(1)=1.09$; $p=0.29$) and only a weak tendency of IS was found ($\chi^2(1)=2.8$; $p=0.09$). The most parsimonious model contained the fixed factor with interactions and the random factors, Item and Subject -- the latter had VOWEL as random slope. No interaction was detected between the SCOPE vs. IS ($\chi^2(1)=0.69$; $p=0.41$), VOWEL vs. SCOPE ($\chi^2(5)=0.53$; $p=0.99$), and IS vs. VOWEL ($\chi^2(5)=3.56$; $p=0.61$).

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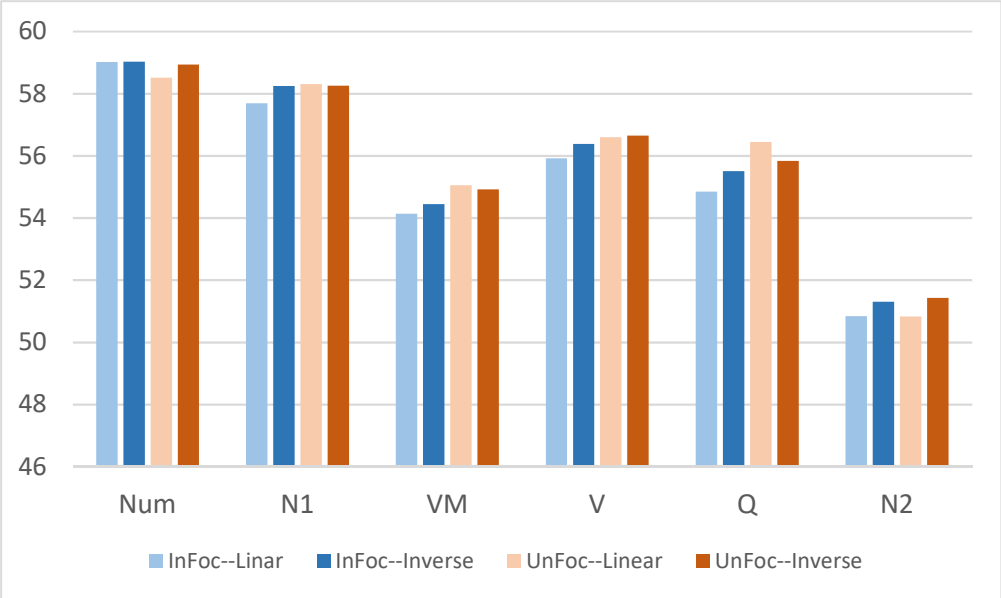

Figure 34. Intensity (dB)

5.1.4 Summary

The above described production experiment was performed to explore the potential role of prosody in the expression of logical scope in grammatically scope-ambiguous doubly quantified sentences that contained no structural focus. The scope reading and the information structural interpretation of target sentences were elicited using a dialogue context and visual stimuli. Two focus structures were crossed with the linear and inverse relative scope interpretations of the two quantified phrases. To my knowledge, this is the first experiment that has examined the manifestation of quantifier scope in prosodic production using a design in which scope interpretation and information structure were crossed experimentally as independent factors. While the results confirmed the effect of information structure, the measured acoustic cues of prosodic prominence were not found to exhibit any significant differences across the two scope conditions of linear and inverse scope interpretation, nor did they reveal any significant interaction of scope and information structure. These outcomes are argued to corroborate the position that quantifier scope itself has no grammatically significant effect on the investigated aspects of prosody in sentence production in Hungarian. While I take the results to be suggestive of the absence of a grammatical effect of scope on prosody in sentence production, further replications of this finding, using a variety of methods, are necessary in order for this conclusion to become firmly established. In order to broaden the empirical basis of this claim, especially valuable would be further studies probing into phonetic variables different to those investigated

DOI: 10.15774/PPKE.BTK.2020.021

in this thesis. Although I examined the main parameters that I expected to be potentially affected based on prior literature, these parameters might be considered for larger phonological units than in this thesis (e.g. for initial syllables rather than initial vowels), and phonetic cues not analyzed here (e.g. vowel quality) may also be fruitfully explored. While the present results cast doubt on the view that quantifier scope can be directly encoded in sentence intonation, they are compatible with the restrictive view instead, i.e. that logical scope is reflected in prosody only in cases in which scope interpretation is a free rider on information structure (a possibility raised for all the cases reviewed in Chapter 3). If correct, this view entails that prosodic correlates of logical scope in themselves do not pose an issue for the Y-model of the grammar, which eschews any direct mapping between the interface components LF and PF.

5.1.5 A follow-up study: a perception experiment – Experiment 4B

In this brief section I present a follow-up perception experiment that is based on a forced choice task. Investigating the same material as described in the previous section, I asked 20 native speakers to pick the matching prosodic realization out of two distinct prosodic realizations. I used the recordings of one of the 8 speakers who participated in Experiment 4A. The rationale behind this follow-up study is that speakers may rely on other prosodic cues in order to distinguish possible readings in perception, different from those that I investigated in the production study. Testing the recordings in perception may reveal extra factors in prosody that might disambiguate between the two possible readings.

To preview the results, it is found that the participants chose the Linear Reading conditions more frequently than the Inverse Reading conditions in the cases of both Indefinite and Universal foci. In the case of the Universal Focus condition, this effect is even stronger. On the one hand, this tendency is quite expected, since it is independently well known that the linear scope reading is generally preferable to the inverse scope reading (see Chapter 2, and also Gyuris and Jackson (2018) for Hungarian experimental data investigating adult language and for Hungarian child language see É. Kiss et al. 2013 and É. Kiss and Zétényi 2017). On the other hand, it is not straightforward why participants chose the linear realizations over the inverse ones even in the case of a context that clearly licenses an inverse scope reading. I conclude that in perception, native speakers cannot differentiate between the two scope readings of an ambiguous doubly quantified sentence which has a controlled information structure.

DOI: 10.15774/PPKE.BTK.2020.021

5.1.5.1 *Experimental question*

Bearing in mind the results of the production study Experiment 4A, I investigated the prosodic realizations of doubly quantified sentences in perception. The main question of the experiment is formulated below:

(136) Do native speakers differentiate between the two prosodic realizations
if a context that disambiguates information structure and the targeted scope reading are both provided?

I expected that the listeners would be able to distinguish most easily between the realizations matching the the two conditions that are most different from each other, namely between the Universal Focus Linear Reading vs. Indefinite Focus Inverse Reading, and the Universal Focus Inverse Reading vs. Indefinite Focus Linear Reading. Therefore I used these comparisons as controls in the experiment.

5.1.5.2 *Materials and methods*

I tested the same dialogues and disambiguating pictures described in the previous section (5.1.3). I picked one of the 8 speakers – a male speaker put accents of the post-verbal universal QP in the wide scope conditions – whose recordings were used in this experiment as auditory stimuli. The forced choice procedure was as follows. First, I displayed the visual stimulus (including the textual dialogue) I used in Experiment 4A. After five seconds two prosodic realizations of the target sentence were played. One item of the pair matched the visual context, while the other one did not. After five seconds I repeated the two recordings in the same order. After this second presentation of the audio stimulus the participants were asked to judge which one of the two prosodic realizations matched the visual stimulus.

There were two lists in which the order of the trials were pseudo-randomized, i.e. even the order of the matching and non-matching realizations were randomly assigned in the pairs. Each condition was compared to each condition, and a participant had to judge each pair. This procedure yielded a 2×2×2×2 design as it is presented in (137), since – naturally – the comparison of identical conditions was excluded (indicated by strikethrough below); each participant had to judge (16-4=)12 conditions, as it is summarized in Table 5.

DOI: 10.15774/PPKE.BTK.2020.021

(137) 2 (IS factor of the audio matching the visual stimulus) ×
2 (Scope factor of the audio matching the visual stimulus) ×
2 (IS factor of the compared audio) ×
2 (Scope factor of the compared audio)

	Matching audio	vs.	Non-matching (compared) audio	
	~~INFocus–Linear~~	~~vs.~~	~~INFocus–Linear~~	[InFoc-Lin] – [InFoc-Lin]
1.	INFocus–Linear	vs.	INFocus–Inverse	[InFoc-Lin] – [InFoc-Inv]
2.	INFocus–Linear	vs.	UNFocus–Linear	[InFoc-Lin] – [UnFoc-Lin]
3.	INFocus–Linear	vs.	UnFocus–Inverse	[InFoc-Lin] – [UnFoc-Inv]
4.	INFocus–Inverse	vs.	INFocus–Linear	
	~~INFocus–Inverse~~	~~vs.~~	~~INFocus–Inverse~~	
5.	INFocus–Inverse	vs.	UNFocus–Linear	
6.	INFocus–Inverse	vs.	UnFocus–Inverse	
7.	UNFocus–Linear	vs.	INFocus–Linear	
8.	UNFocus–Linear	vs.	INFocus–Inverse	
	~~UNFocus–Linear~~	~~vs.~~	~~UNFocus–Linear~~	
9.	UNFocus–Linear	vs.	UnFocus–Inverse	
10.	UnFocus–Inverse	vs.	INFocus–Linear	
11.	UnFocus–Inverse	vs.	INFocus–Inverse	
12.	UnFocus–Inverse	vs.	UNFocus–Linear	
	~~UnFocus–Inverse~~	~~vs.~~	~~UnFocus–Inverse~~	

Table 5. The 12 conditions of the follow-up perception experiment

The conditions were presented in 2 lists containing 4 lexicalizations complemented with additional 48 filler conditions, hence each of the 20 participants had to judge 96 tokens. The experiment was conducted in a soundproof room and the participants used high-quality headphones. Additional three practice trials were presented to the participants.

DOI: 10.15774/PPKE.BTK.2020.021

5.1.5.3 Results and analysis

First, I evaluated the forced choice judgments of the participants by giving 1 point if they chose the audio stimulus that matched the visual stimulus, while giving 0 points if they chose the non-matching audio stimulus. Figure 34 presents the mean of the scores by condition. In this figure the first condition name represents the matching audio while the second one stands for the compared non-matching condition. For instance, in the case of the first condition, the focused Indefinite in Linear scope reading (IL) was compared to its Linear scope reading counterpart (II). The prosodic realizations of these conditions were played twice, and the matching picture stimulus was the focused Indefinite in Linear scope reading. The tables shows the 12 conditions given in Table 5. in the very same order. For instance the 6th condition (coded as II-UL) compared the prosodic realization of focused Indefinite with Inverse (II) scope interpretation to the focued Universal quantifier with Linear reading.

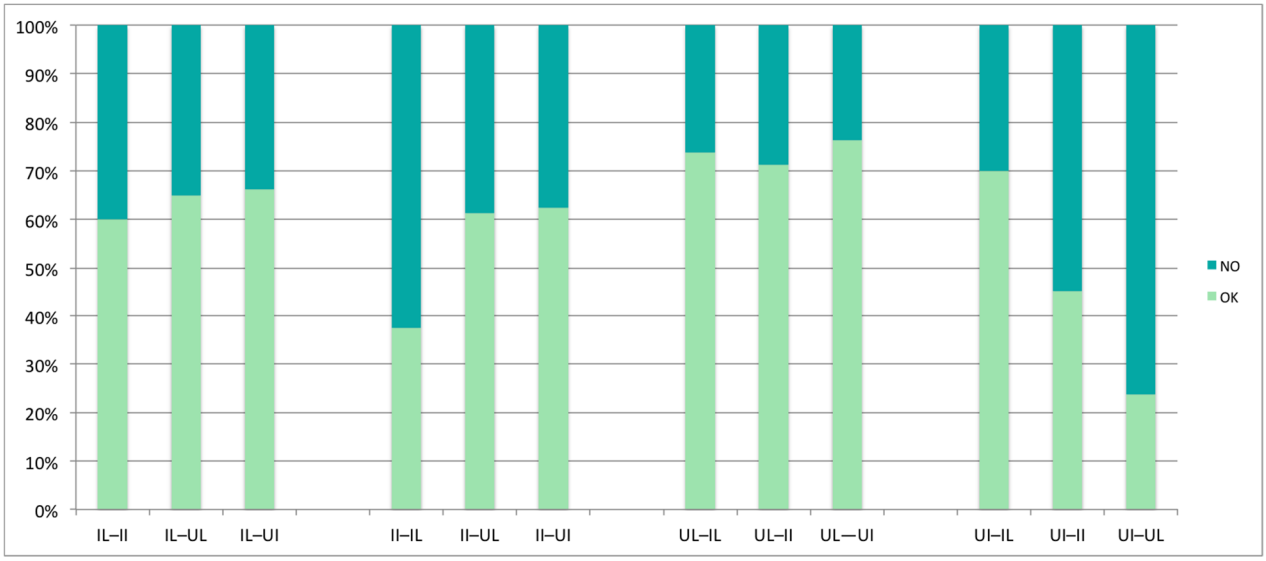

Figure 35. The mean rate of correct and incorrect responses by condition (in percentage)

First of all, it seems that the control comparisons (i.e. the comparisons of the conditions that differed from each other the most, namely, both in focus status and in scope reading) worked as expected. By comparing the Indefinite Focus Linear and the Universal Focus Inverse condition, a mean result of 66.25% correct responses was obtained; by comparing the Indefinite Focus Inverse condition to the Universal Focus Linear resulted in 61.25% correct responses. In the case of the Universal Focus Linear and Indefinite Focus Inverse comparison, the result is

DOI: 10.15774/PPKE.BTK.2020.021

even higher: 71.25%. Last but not least, comparing the Universal Focus Inverse to the Indefinite Focus Linear resulted in 70% correct choices.

Second, it seems that the listeners preferred the realization of the Linear Scope readings even if the visual stimuli depicted an Inverse Scope scenario. That effect can be read off the results of the following comparisons. Presenting a Linear reading scenario, the participants chose the Linear audio mostly: Indefinite Focus Linear – Indefinite Focus Inverse: 60%; Universal Focus Linear – Universal Focus Inverse: 76.25%. On the other hand, in the case of an Inverse scope scenario, the listeners failed to choose the matching audio stimulus, the Inverse Scope realization: Indefinite Focus Inverse – Indefinite Focus Linear: 37.5%; Universal Focus Inverse – Universal Focus Linear: 23.75%. For the sake of clarity, Figure 35 shows the ratio of choosing the Linear Scope realization over the Inverse Scope realization in these four critical comparisons.

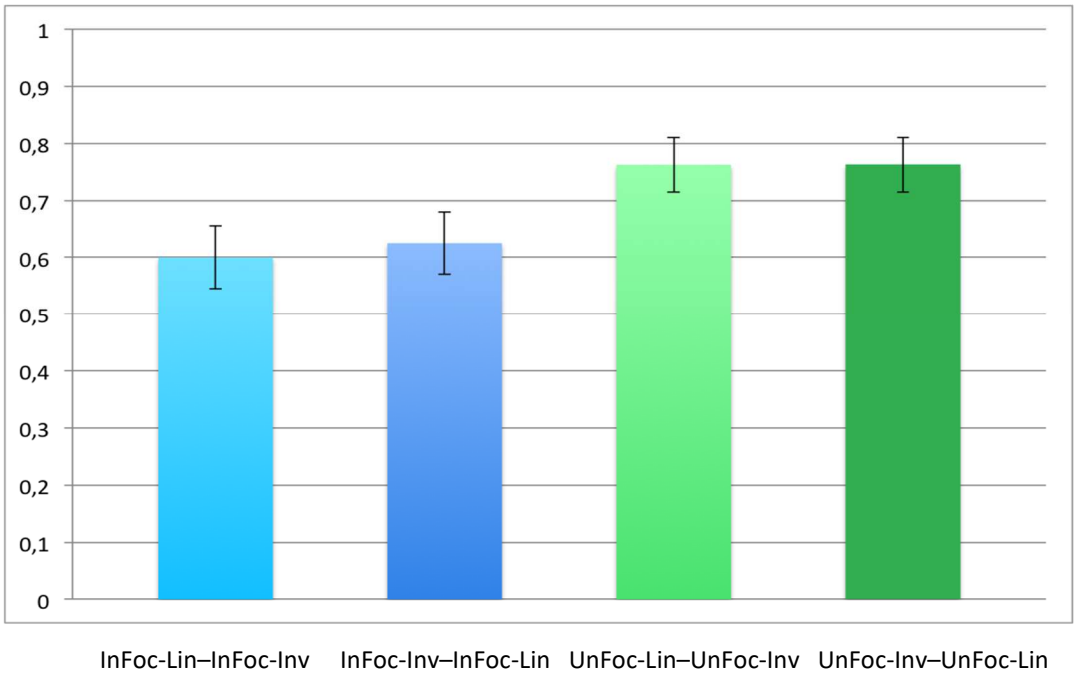

Figure 35. The ratio of choosing Linear Scope audio over the Inverse Scope audio

Taking the score of choosing the Linear reading as a dependent variable in this smaller set of data (see Figure 35) I conducted a logistic regression analysis (using the glmer function in R). The model contained the two fixed factors (IS: Indefinite Focus vs. Universal Focus; SCOPE: Linear vs. Inverse) with an interaction, and the subject and item as random factors (having the fixed factors with interaction as random slopes). There was no main effect detected

DOI: 10.15774/PPKE.BTK.2020.021

in SCOPE factor ($\chi^2(1)=0.04$; $p=0.84$), while IS had a main effect ($\chi^2(1)=8.43$; $p<0.01$). No interaction was found between the fixed factors ($\chi^2(1)=0.06$; $p<0.81$). After merging the data into the two IS levels, a final binomial test (binom.test in R) revealed that both Indefinite Focus (Number of success=98; Number of trials=160: 61.25%; $p<0.01$) and Universal Focus (Number of success=122; Number of trials=160: 76.25%; $p<0.0001$) differed significantly from the chance level (50%). These data show that the participants did not differentiated between the two scope readings in perception but they perceived IS differences behind the prosodic realizations.

5.2 Information structure and Scope: QP vs. QP

As the findings of the production experiments revealed, specifically in the case of negative sentences in Chapter 4 and doubly quantified sentences in Section 5.1, it can be assumed that the information structural status of a quantified NP (which may have an impact on the scope relations of the sentence) is naturally reflected in prosody. In this section I turn to the other crucial empirical question of the thesis, which is formulated in (EQ.ii.a):

(**EQ**) ii. a. Can two sentences that have identical information structures have different (linear or inverse) scope interpretations?

As it was discussed in Chapter 3, the scope interpretation of doubly quantified sentences is known to be influenced by a variety of contextual factors, among them, information structure. While the non contrastive topic status of an NP has been recurrently argued to give rise to wide scope (see e.g. Ioup 1975, Krifka 2001, Ebert & Endriss 2004 among others), the effect of focus status remains controversial: in the literature it has been linked both to narrow scope and to wide scope.

This section presents an empirical study designed to explore whether the focus status of a quantified NP affects its scope-taking options by biasing its interpretation either towards narrow scope or towards wide scope with regard to another, non-focal and non-topical quantified NP in its background. The experiment was based on a rating task using contextualized target sentences accompanied by visual stimuli. In preview, while the study detects a mild advantage of linear scope over inverse scope, as well as a markedness effect of the post-verbal focus construction, the focus status of quantified NPs is not found to interact with their scope interpretation. From a broader perspective, the finding that focus sharply differs from topic in

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terms of (the lack of) its effect on scope corroborates approaches that view topic and focus as belonging to two distinct dimensions of information structure. Two follow-up studies probed the relative degradedness of the focus condition experienced in the main experiment. The first one tested the effect of the non-canonical post-verbal focus placement, while the second experiment investigated the complexity of the focus structure. The results clearly showed that the non-canonical, postverbal position of the focused element is not the source of the relative degradedness but the complex focus structure.

5.2.1 Specific research questions

As it was reviewed in Chapter 3, the effect of focus as an information structural role on scope taking is not as straightforward as the effect of the topic status. In (138) I formulate the two main hypotheses (to be referred to respectively as the Focus Narrow Scope hypothesis and the Focus Wide Scope hypothesis) as follows:

(138) a. **Focus Narrow Scope (FNS) hypothesis**

If a quantifier is associated with focus status, then it will (prefer to) have narrow scope with respect to non-focal, non-topical scope-bearing elements in the same finite clause.

b. **Focus Wide Scope (FWS) hypothesis**

If a quantifier is associated with focus status, then it will (prefer to) have wide scope with respect to non-focal, non-topical scope-bearing elements in the same finite clause.

The objective of the following experiment is to address this latter controversy regarding the effect of focus on the scope of quantified phrases by experimental means, using a rating task. I explore whether and how the Focus status of a quantifier bears on the availability of its surface narrow scope and on its inverse wide scope interpretation.

This experiment investigates the interpretation of structures in which one of two scope-bearing NPs is pre-verbal while the other is post-verbal (for the detailed description of the experimental sentences see in Section 4.1.1). The objective is to compare the availability of straight and inverse scope interpretations in sentences that have identical information structures. In doing so, I explore whether the focus status of a post-verbal quantifier affects the scope

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interpretations available to it. Two types of possible outcomes present themselves that license a stronger and a weaker affirmative response to this core question, respectively. In (iii.a) and (iii.b) below I formulate these possibilities in the form of questions.

The first possible outcome is that a focused post-verbal quantifier can take only linear narrow scope (corresponding to the FNS hypothesis) or only inverse wide scope (corresponding to the FWS hypothesis); see (iii.a). The main information structural status typically discussed in concert with focus is givenness. On the basis of the literature referenced above, the givenness of a quantifier is not expected to exert any direct influence on its scope interpretation in itself, since givenness is an informational structural property distinct both from focus status and from topic status. However, if the givenness of a quantifier is linked to the focus status of another scope-bearing element in the clause, then it may nevertheless have an indirect effect on the scope of the quantifier. This is so, in particular, if the quantifier is given because it belongs to the discourse-given background of another, focused scope-bearing element in the sentence. Then by the FNS hypothesis the given quantifier is expected to have wide scope with respect to the focused scopal element, and by the FWS hypothesis it is expected to take narrow scope with respect to the other scope-bearing element. These diverging predictions are formulated as a question in (iii.b).

(**EQ**) iii. a. Keeping information structure constant, does a focused post-verbal quantifier permit only inverse scope or only linear scope with respect to a pre-verbal scope-taking element, or both?

b. Keeping information structure constant, does a given post-verbal quantifier that is part of the background of a focused pre-verbal scope-taking element permit only inverse scope or only linear scope with respect to it, or both?

As stated, the FNS and the FWS clearly make opposite predictions with respect to which of the two scope interpretations will be favored in doubly quantified sentences in which one of the two quantifiers functions as a focus. For any influence of focus to be conceived of as a grammatical effect in the data that corresponds to the predictions of FNS/FWS, the influence may, but does not need to, emerge as (quasi-)absolute. The effect of the FNS/FWS would be (quasi-)absolute if the scope interpretation predicted to be available turned out to be (near) perfect and the scope reading predicted to be unavailable turned out to be (near) impossible. As mean ratings in judgment experiments rarely come close to extreme values, what is more

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realistic to expect is a pattern of judgments in which the scope interpretation that is predicted to be available comes out as better than average and the one that is predicted to be impossible is found to be worse than average, with the difference between the two being sufficiently robust. What I will be looking for are differences that have at least a medium effect size (i.e., with Cohen's d reaching at least 0.5, Cohen 1988; namely, differences between mean ratings that are 0.5 pooled standard deviations or larger). Idealizing greatly, I may take such outcomes to permit an affirmative response to (139.b) below.

Assuming it turns out that that the answer to both (iii.a) and (iii.b) is negative (i.e., within the same overall information structure, the focused or given post-verbal quantifier can take both linear scope and inverse scope), a further question arises. Namely, it still remains a possibility that the information structure with a focused quantifier (139.a) or the one with a given quantifier (139.b) exhibits a preference for either one of the two accessible scope interpretations: that is, one of the two scope readings is more accessible than the other:

(139) Is there a scope preference favoring one of the two scope interpretations?
   a. Does a focused post-verbal quantifier show relative preference for either the linear or the inverse scope reading?
   b. Does a given post-verbal quantifier that is part of the background of a focused pre-verbal scope-taking element show relative preference for either the linear or the inverse scope reading?

If the opposite preferences with focused and given post-verbal quantifiers were found, then the conclusion would be reached that although neither the FNS nor the FWS can be maintained as accurate generalizations about the grammar, focus status still has some linguistically relevant, pragmatic effect on the scope interpretation of quantifiers in the same direction as expected under the FNS or FWS.

5.2.2 Materials

I addressed the experimental questions in (iii.a, b) of the previous subsection by investigating the scope interpretation of sentences like (129, 134) above, which contained a post-verbal universal quantifier phrase *mindegyik melódiát* 'each melody' and a pre-verbal distributive bare numeral phrase *négy előadó is* 'four singers too'. The experimental design and the critical items were identical to the production experiment described above in Section 5.1.1. The task of the

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participants was to judge the naturalness of Speaker B's sentence as an expression of the target meaning (namely, what happened in reality, illustrated in Picture B). Judgments were given as a score on a 5-point Likert scale (5 being the best and 1 being the worst score). The task was explained through written instructions. Three practice trials (similar to target trials, but sufficiently different from them) helped participants familiarize themselves with the task.

In this experiment as well, five lexicalizations were included for each of the four conditions, yielding 20 target trials. These were complemented with 10 control and 30 filler items. Every 10 control items had the same form: they contained a distributive indefinite bare numeral phrase and a universal quantifier (headed by *minden* 'every') in the linear order NumP > UQP, both in the pre-verbal field. The information structure of controls was invariable too: NumP functioned as an informationally new corrective focus, while the UQP was given. A sample control item is provided in (140).

(140) Control

A: context: *Minden zenész cask két darabot játszott el.*
every musician only two piece.of.music.ACC played VM
'Every musician played two pieces of music.'

B: Nem igaz!
not right
'That's not right.'
Három darabot is minden zenész eljátszott.
three piece.of.music.ACC DIST.PRT every musician VM.played
'Every musician played three pieces of music.'

The target interpretation associated with all the controls was the inverse scope reading, based on the context and the associated picture stimuli. Recall from section 2.2.4.1 that according to standard descriptions of Hungarian the linear scope interpretation should be strongly preferred in doubly quantified sentences that have both scope-taking elements before the verb. Therefore I expected control items to be judged relatively low. Note that the test condition that matched the control condition both in terms of the assignment of IS roles and in terms of the precedence relations between the focused and the given phrase was the Wide–Given condition: in both of these conditions the focussed DistNumP precedes the given UQP, and the targeted interpretation is the inverse wide scope of the UQP.

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The 30 filler trials were constructed to be very similar to the trials in the critical and control conditions in their composition. They contained SVO and OVS target sentences involving numeral phrases and UQPs as the arguments. Subjects were Agents, and Objects were Themes/Patients, and the predicate was always a telic, perfective, past tense particle verb, just like in the critical and control conditions. Of the total of 60 test items, a little over half (35) had inverse scope as the targeted reading, and a little less than half (25) had linear scope as the targeted interpretation. Similarly, 25 had SVO word order and 35 had OVS.

Trials were presented in 30 pseudo-randomized orders that had filler items separate every two consecutive test items. 42 university students participated in the experiment, who received payment for their participation. The experiment, compiled and run with SR's Experiment Builder software, was conducted in a lab setting.

5.2.3 Results and analysis

The responses from the 42 participants first entered a descriptive statistical analysis. Figure 36 provides an overview of the distribution of judgments in the four experimental conditions. In each condition by far the most frequent rating was 5.

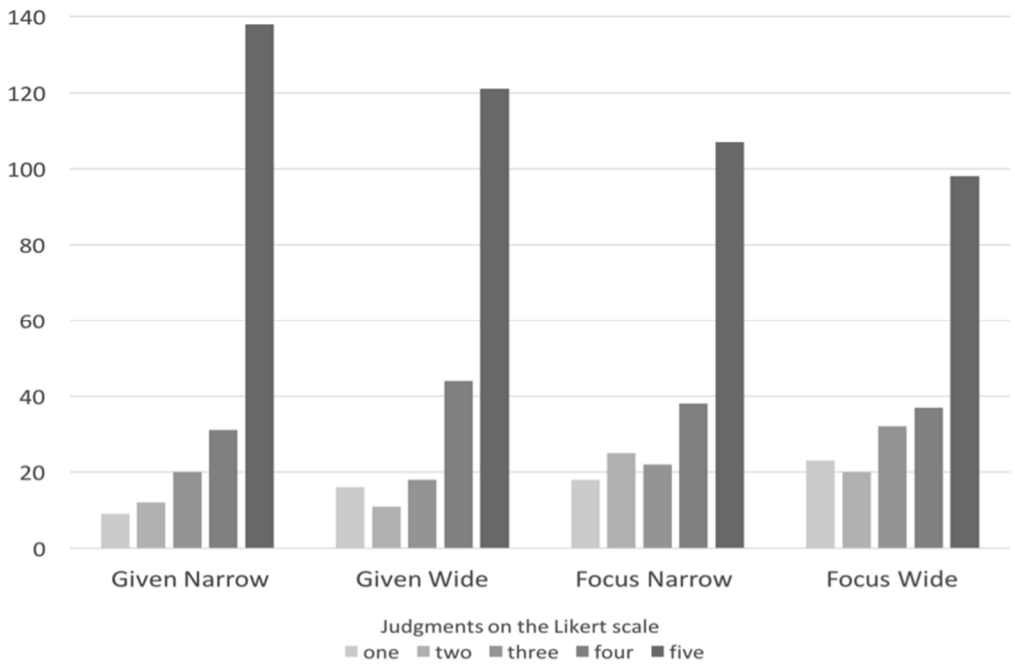

Figure 36 The distribution of the judgments by the target conditions

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The mean of the raw judgment data was around 4 in all four critical conditions, as depicted in Figure 37:

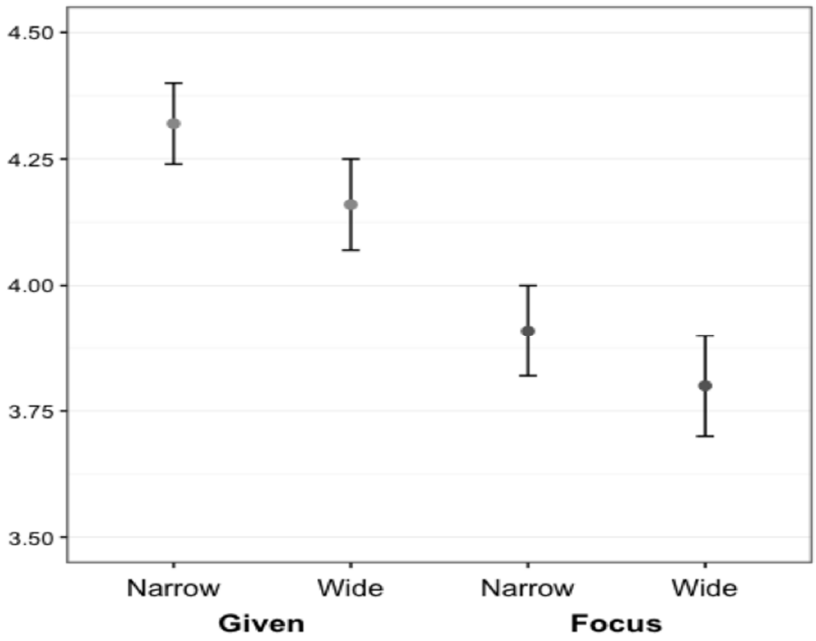

Figure 37. Dot plot of the means of target conditions with error bars (SE)

Given conditions were rated somewhat higher (M(Given–Narrow, raw)=4.32, SD=1.13, 95% CI(±0.15) [4.17, 4.47]; M(Given–Wide raw)=4.16, SD=1.24, 95% CI(±0.17) [3.99, 4.32]) than Focus conditions (M(Focus–Narrow, raw)=3.91, SD=1.36, 95% CI(±0.18) [3.72, 4.09]; M(Focus–Wide, raw)=3.80, SD=1.40, 95% CI(±0.19) [3.61, 3.98]).

As the data did not meet the requirement of normality, I used a non-parametric method for the statistical analysis. I considered the effect of the participants (Subject) and the experimental items (Item) as random factors in addition to the fixed factors: Scope and Iss. I fitted cumulative link mixed models to the raw data points and reduced the full model using the standard method of Likelihood Ratio Tests (LRTs). The model reduction revealed no significant interaction of the two experimental factors (LR.stat (1)=0.32; p=0.57).

As for the random effects, the variance of Subject (N=42; s=1.57; s2=2.45) turned out to be larger than the variance of Item (N=20; s=0.19; s2=0.04). The LRTs showed that while Subject has a significant random effect (LR.stat(1)=231.61; p<0.001), the item does not (LR.stat(1)=1.02; p=0.31). The most parsimonious model obtained by stepwise backward elimination included the two fixed effects along with Subject as a random intercept. In other words, it was found that both Scope (LR.stat(1)=5.53; p=0.02) and Iss (LR.stat(1)=28.06;

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p<0.001) had significant main effects. The effect size (ES) of Iss is small (Cohen's d = 0.30; CI:[0.16, 0.44]), and that of Scope is even smaller (Cohen's d=0.11; CI:[0.03, 0.24]).

Planned comparisons – contrasting the least-squares means of the conditions – revealed that focused narrow scope UQPs and focused wide scope UQPs did not receive significantly different ratings, nor did given narrow scope UQPs differ from given wide scope UQPs (Focus–Narrow vs. Focus–Wide: *z-ratio*=1.09, p=0.27; Given–Narrow vs. Given–Wide: *z-ratio*=1.81, p=0.07). At the same time, the difference between given wide scope and focused wide scope UQPs, and the difference between given narrow scope and focused narrow scope UQPs turned out to be statistically significant (Given–Wide vs. Focus–Wide: *z-ratio*=-2.91, p=0.004, Given–Narrow vs. Focus–Narrow: *z-ratio*=-3.6, p<0.001).

The effect sizes between the target conditions were calculated using Cohen's d method in paired comparisons. This revealed a negligible ES of Scope both between the Given conditions (Given–Narrow vs. Given–Wide: d=0.12; 95% CI:[-0.06, 0.32]) and between the Focus conditions (Focus–Narrow vs. Focus–Wide: d=0.07; 95% CI:[-0.12, 0.26]). While they can still be categorized as small, the ES of Iss was somewhat larger in the case of the two Narrow conditions (Given–Narrow vs. Focus–Narrow: d=0.3; 95% CI:[0.12, 0.5]) as well as in the case of the two Wide conditions (Given–Wide vs. Focus–Wide: d=0.26; 95% CI:[0.07, 0.46]).

Control items received a relatively low mean score: M(Control, raw)=2.69, SD=1.34, 95% CI(±0.13) [2.56, 2.82]. Recall that the Control condition involved a given UQP with inverse wide scope over a focused NumP, with both scope-bearing NPs placed in the pre-verbal field. While the Focus–Wide condition also triggered inverse wide scope, the target condition that matched the controls both in terms of the assignment of IS roles (UQP=given, NumP=focused) and the relative order of the two scopal phrases (NumP > UQP) is the Given–Wide condition. The latter two conditions only differed with regard to the placement of the UQP, which was post-verbal in the Given–Wide condition, while it was pre-verbal in the Control condition. The results in the latter two conditions are strikingly different.

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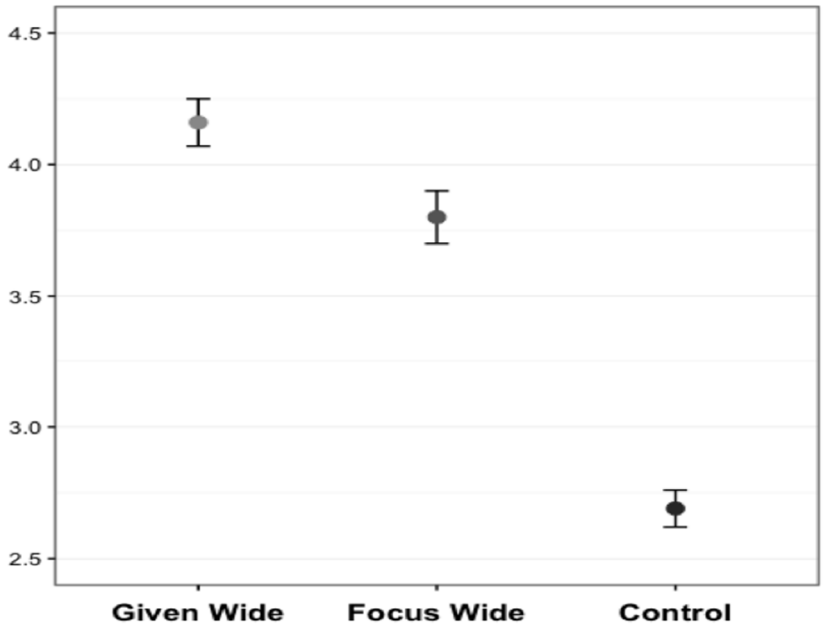

Figure 38. Dot plot of the Wide and the Control conditions with error bars (SE)

I analyzed the data of the Given–Wide, the Focus–Wide and the Control conditions with cumulative link mixed effect models. After fitting the most parsimonious model (which contained both Subject and Item as random factors, with random slopes in the Subject factor), I contrasted the least-squares means of the three conditions. The pairwise comparisons with Tukey-correction revealed the following pattern. As before, the two target conditions differed from each other (Given–Wide vs. Focus–Wide: *z-ratio*=-2.47, *p*=0.04). The difference between the Given–Wide and the Control conditions (*z-ratio*=-7.87, *p*<0.001) as well as between the Focus–Wide and the Control conditions (*z-ratio*=-5.73, *p*<0.001) was highly significant. Crucially, in contrast to the negligible to small effect sizes found in the comparisons of the target conditions, the ESs associated with the difference between the Control condition and each of the Wide target conditions were large (Given–Wide vs. Control: *d*=1.13, 95% CI:[0.95, 1.3]; Focus–Wide vs. Control: *d*=0.82, 95% CI:[0.64, 0.99]).

5.2.4 Interim summary

These results provide clear answers to the research questions formulated in section 5.2.1 Both scope interpretations turned out to be highly accessible both in the Focus and in the Given conditions (with mean responses around 4 on the 5-point scale, having relatively narrow CI ranges). This is squarely at odds with both the FNS hypothesis in (138.a) and the FWS hypothesis in (138.b) as generalizations about the scope reading.

DOI: 10.15774/PPKE.BTK.2020.021

However, the relative differences across the four conditions did not converge with the predictions of either the FNS or the FWS. This points not just to a lack of a grammatical FNS- or FWS-effect, but also to an absence of scope preferences of a purely pragmatic nature along the lines of the FNS or the FWS (138).

I turn now to the two main effects found in the experiment. First, UQPs with narrow scope were rated higher than those with wide scope. This in itself is not unexpected insofar as non-linear scope has long been known to be more marked and less easily accessible than linear scope (Ioup 1975, Kurtzman & MacDonald 1993). Arguably, this is an effect of the extra processing complexity incurred by non-linear scope (Tunstall 1998, Anderson 2004), rather than a grammatical effect. Indeed, the size of this effect is rather small (Cohen's d=0.11), which would be implausible to treat as arising from a grammar in which one scope interpretation is grammatically licensed while the other is deemed grammatically unavailable. Further, it is reasonable to expect a scope interpretation that has no grammatically licensed representation to be rated at least 0.5 standard deviations below the mean rating, corresponding to -0.5 in terms of z-scores. This is not the case in the data: even the lowest mean z-score among the target conditions was 0.20.

It would also be difficult to argue that the rating task itself was not sufficiently sensitive to the different scope interpretations. Recall that the targeted scope interpretation was secured by two different means: both by the picture stimuli and by the coherence of the dialogue. As for the first of these, Bott & Radó (2007) demonstrate that drawings of the kind that were used in the study, with connecting lines between sets of items, are reliable as stimuli to trigger particular scope interpretations, even when the items are represented by dots instead of images. Furthermore, the relative scope was fixed by the drawings twice: it was already fixed in the left-hand side picture, accompanying Speaker A's sentence, and it was then reinforced by the scopally identical right-hand side picture, accompanying Speaker B's reply containing the target sentence. Moreover, the wide scope element invariably corresponded to the set of figures on the left-hand side of each picture, and each of these figures was linked in the targets to multiple figures on the right-hand side of the same picture. This latter fact made only the targeted distributive scope interpretation coherent with the picture, and ruled out the non-targeted distributive scope. Note also that only distributive scope readings were relevant to begin with, since both scopal elements were inherently (lexically) distributive in nature. With regard to the role of the dialogue in securing the targeted scope reading, the dialogues were coherent only if Speaker A's and Speaker B's sentences were assigned one and the same relative scope interpretation.

DOI: 10.15774/PPKE.BTK.2020.021

Most importantly, the results from the control condition exclude the possibility that participants were not sufficiently sensitive to the targeted scope interpretations in the experiment, given the complexity of the experimental task. Recall that the control condition consisted of target sentences with both the NumP and the UQP in a pre-verbal position, which, according to standard syntactic descriptions, strongly disfavor the inverse scope interpretation. Indeed, the controls received a rather low rating in the experiment. Their mean judgment (z=-0.65) was not only much lower than that of the particular test condition that matched the control condition both in terms of information structure and in terms of targeted scope (namely, the Given–Wide condition; z=0.49), but it was also far lower than the mean judgment of all test items (which corresponds to z=0). The control condition thus vividly confirms that participants were sensitive to the targeted scope interpretations.

A second, and perhaps more interesting, effect identified in the experiment was that both the linear scope reading and the inverse scope reading were rated somewhat lower in the Focus condition than in the corresponding Given condition (see Fig. 37). Note that both scope interpretations were rated lower in the Given conditions than in the Focus conditions in the same way, without any interaction between them. Although this effect is tangential to the research questions the present study set out to address, I nevertheless venture to offer some speculations regarding the possible reasons behind it. As both differences between the respective means are smaller than half a point on the 5-point Likert-scale, I suggest that the detected difference is plausibly not a grammatical effect; rather, it may be a markedness effect. In the next two sections I scrutinize this latter markedness effect and the effect of the complexity of the focus structure.

5.2.5 A follow-up study: Non-canonical focus position

In this follow-up experiment I tested the effect of the focus position investigating the phenomenon that the Focus conditions were less acceptable in Experiment 5A. I used the Focus stimuli from Experiment 5A and modified according to a one-factor design (with two levels). In preview, the results show that if the universal quantifier with the contrastive focus IS status takes place in the pre-verbal position, then the participants judge this condition as even more unacceptable. By comparison, the construction I used as a target in the former experiments received rather high scores on the 7-point Likert scale. These findings show that the relative degradedness experienced in the former study is not due to the post-verbal focus position.

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5.2.5.1 *Research question*

As the results of Experiment 5A showed, the Focus conditions exhibit a relative degradedness with respect to the Given conditions. In this experiment I address the question formulated in (140) to find out whether the source of this degradedness is that the information structurally corrective focus is not placed in the pre-verbal field. The specific question is as follows:

(140) Does the non-canonical focus position have an effect on the acceptability of (target) sentences presented in (129)?

In other words, is what is marked about the target sentences of the Focus conditions the syntactic position of their focus? UQPs are unable to occupy the designated pre-verbal focus slot. Their distribution is unaffected by focusing: whether or not they are foci, they can be fronted to a pre-verbal scope position (distinct from the designated focus position), or they can remain post-verbal (for more details see Section 2.2.3). Importantly, however, a sentence in which the narrow focus UQP occupies a post-verbal position deviates from the most frequent pattern of narrow focus sentences, in which the focus is in the pre-verbal field. In this sense, the word order of the target sentences in the Focus conditions is a marked order. This contrasts them with target sentences in the Given conditions, in which the narrow focus (corresponding in these conditions to the NumP) was pre-verbal.

What is more, not only the syntactic position but also the prosodic position of the focus is marked in the target sentences in the Focus conditions. This is because in unmarked sentence prosody (viz. the prosody of broad focus sentences) the main prominence is located at the left edge of the predicate phrase (É. Kiss 1994, 2002). As this position coincides with the common pre-verbal position of narrow foci, the prosody of sentences with a pre-verbal narrow focus (such as the target sentences in the Given conditions) does not need to deviate from unmarked prosodic relations: the pre-verbal focus bears the main prominence in default sentence prosody (Szendrői 2003). By contrast, when the focus happens to be post-verbal – as in the Focus conditions, with a focused post-verbal UQP – deviation from default prosodic relations is required: the main sentence-level prominence carried by the focused UQP is not aligned with the left edge of the predicate phrase. This prosodic markedness may have resulted in the slightly decreased acceptability of sentences in the Focus conditions, as compared to the Given

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conditions, which required no deviation from default prosodic prominence relations.[29] I investigate this very effect in this follow-up experiment.

5.2.5.2 Materials

I used the same visual stimuli and procedure that I presented in section 5.1.2, although I modified the textual context as follows. In the Post-Verbal condition I used the very same target sentence as in the case of the Universal Focus condition Experiment 5A, while in the Pre-Verbal condition I placed the universal quantifier into the preverbal field. Crucially, the position concerned is not a structural focus position, since distributive quantifiers cannot be situated in the immediately pre-verbal structural focus position in Hungarian (see Section 2.2.4). As in the case of the former experiments, I refer to the quantifiers concerned as focused, because they serve as a contrastive focus in the textual context. Syntactically, such pre-verbal universal QPs sit in what is labeled Distributive Phrase, hence no VM–V inversion occurs (for more details, see section 2.1.4, and É. Kiss 2002 among others). The design of this Experiment 5B was the following:

2(Factor: Pre-Verbal vs. Post-Verbal) ×5(Lexicalizations) + 20 fillers = 30 trials per person

The examples below present a sample context and two target sentences:

(141) a. Context:

A: *Négy író is csak két művet fordított le.*
four writer DIST.PRT only two work translated VM.
'Four writers translated only two works.'

b. 1 Post-Verbal target stimulus

B: *Nincs igazad. Négy író is le-fordította mindegyik művet.*
not right four writer DIST.PRT VM-translated each work
'You are not right. Four writers translated each work.'

[29] Prosodic processing is known to take place in the course of silent reading (Implicit Prosody Hypothesis, Fodor 2002), and to thereby affect acceptability ratings (e.g., Kitagawa & Fodor 2006).

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c. 2 Pre-Verbal target stimulus

B: *Nincs igazad. Négy író is mindegyik művet le-fordította.*
not right four writer DIST.PRT each work VM-translated
'You are not right. Four writers also translated each work.'

31 native speakers participated in the experiment. I filtered out an informant who used almost exclusively the 6th point on the scale (in 28 cases out of 30). The judgments of the remaining 30 participants entered the analysis.

5.2.5.3 *Results and analysis*

Observing the medians of the two conditions, it is clear that the Pre-Verbal condition is just around the middle of the 7-point Likert scale, while the Post-Verbal condition received 6 as a median score. After transforming the raw data into z-scores I used linear mixed effect models to probe whether the two conditions differ from each other. The final model contained the fixed factor, and the Item and the Subject as random factors (including the fixed factor as a random slope). The model detected a rather strong main effect of the fixed factor ($\chi^2(1)=20.87$; $p<0.0001$), namely that the Post-Verbal condition is significantly more acceptable than the Pre-Verbal condition.

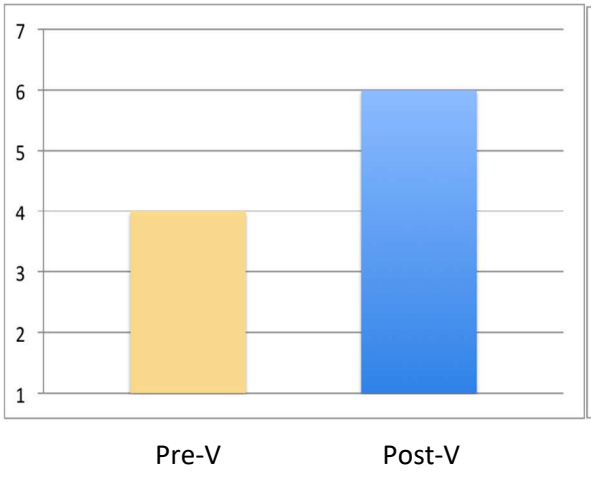

Figure 39. Median values of the experiment

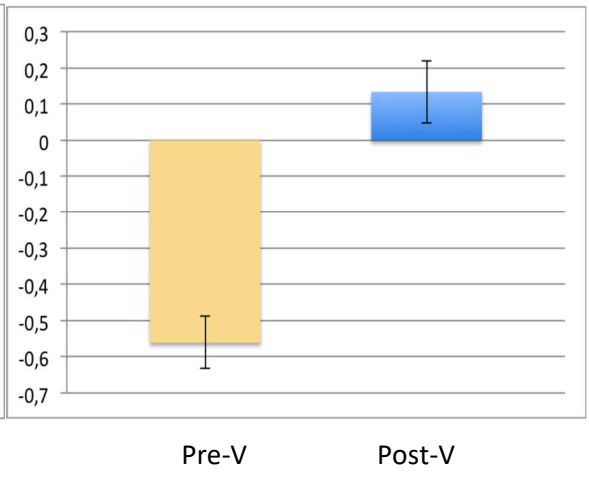

Figure 40. Mean values (*z*-score) of the experiment

The results clearly show that the source of the relative degradedness of the Focus conditions is not the surface position of the information structurally focused universal QP. The next section reviews another follow-up study, which investigates the complexity of the focus structure in

DOI: 10.15774/PPKE.BTK.2020.021

the target sentences of Experiment 5A, since in the main Experiment 5A, the both Focus conditions were relatively degraded compared to the Given conditions.

5.2.6 A follow-up study: The complexity of the focus structure – Experiment 5C

The distributive particle *is* ('too') gives not only a distributive reading to the numeral phrase to which it is attached, but – pragmatically – it provides it with focus-interpretation as well. *Is* ('too') can be defined as a focus particle, since it indicates that there is another alternative of which the background part holds. In the case of bare numeral phrases, this particle may indicate that the number contained in the numeral NP is high relative to other, perhaps more expected alternatives. According to the Roothian definition of focus, the marking of the relevance of alternatives constitutes focus-marking (for more details, see section 2.1.4).

5.2.6.1 *Research question*

The aim of this experiment was to test whether the participants judge those target sentences more acceptable in which the distributive particle does not modify the numeral indefinite. The specific research question is formulated as:

(142) Does the complexity of the focus structure have an effect on
the acceptability of (target) sentences presented in (129)?

5.2.6.2 *Materials*

In this follow-up experiment, I used the same stimulus and design already presented in 5.1.2 and 5.2.5.2, although I modified the context and target sentences as follows. The universal quantifiers were placed in the preverbal DistP position, while the two versions of the numeral indefinite, namely one version with (in a condition named Two Foci) and one version without (in a condition named One Focus) the distributive quantifier, remained in situ. Crucially, the information structural status of the indefinite in both cases was given, while the pre-verbal universal quantifier received a focus status. Hence in the case of the One Focus condition, only the preverbal universal quantifier has focus status, while in the condition Two Foci, both the universal quantifier and the numeral indefinite count as foci, because of the distributive particle attached to the latter. The design was the following:

DOI: 10.15774/PPKE.BTK.2020.021

2(Factor: One Focus vs. Two Foci) × 5(Lexicalizations) + 20 fillers = 30 trials per person

A sample of the two conditions is presented below:

(143) One Focus condition

a. Context:
   A: *Két olyan mű van, amit lefordított négy író.*
      two such work are that VM.translated four writer.
      'There are two works that were translated by four writers.'
b. Target:
   B: *Nincs igazad. Mindegyik művet le-fordította négy írót.*
      not right each work.ACC VM-translated four writer
      'You are not right. Each work was translated by four writers.'

(144) Two Foci (main Focus and Second Occurrence focus) condition

a. Context:
   A: *Két olyan mű van, amit le-fordított négy író is.*
      two such work are that VM-translated four writer DIST.PRT
      'There are two works that were translated by four writers.'
b. Target:
   B: *Nincs igazad. Mindegyik művet le-fordította négy író is.*
      not right each work.ACC VM-translated four writer DIST.PRT
      'You are not right. Each work was translated by four writers.'

The same 31 native speakers participated in this experiment who enrolled in the follow-up Experiment 5B, hence I excluded the same informant who used mostly only the 6th point on the scale, as it was mentioned above. The judgments of the remaining 30 participants entered the analysis.

DOI: 10.15774/PPKE.BTK.2020.021

5.2.6.3 *Results and analysis*

The medians of the two conditions revealed that both conditions are quite acceptable, since the structure with one focus received 6 as median, while the structure with two foci was judged 5 in median score, see Figure 40. I transformed the data into *z*-scores and used linear mixed effect models to probe whether the two conditions differ from each other. The final model contained the fixed factor, and the Item and the Subject as random factors (including the fixed factor as a random slope). The model detected a main effect of the factor ($\chi^2(1)=5.23$; $p=0.02$), namely that the structure containing one focus is significantly more acceptable than its two foci counterpart.

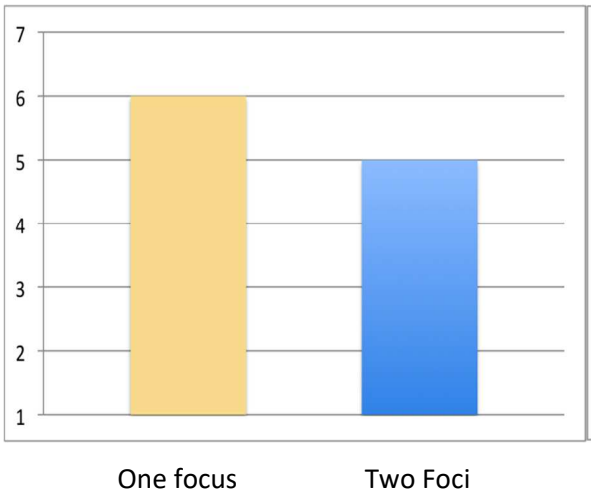

Figure 41. Median values of the experiment

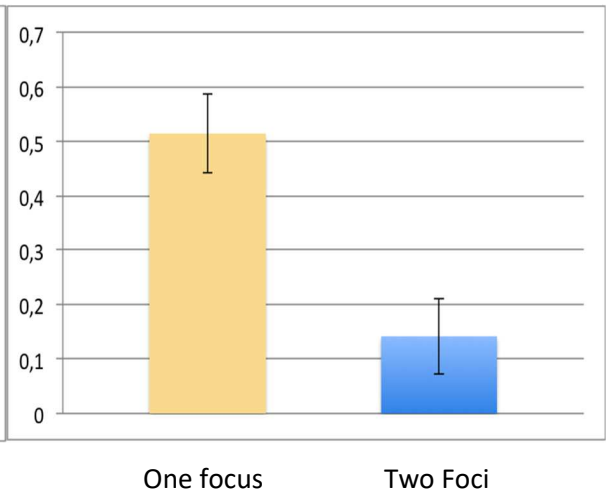

Figure 42. Mean values (z-score) of the experiment

This difference may reflect the extra load on the processor that two foci present, since both structures are otherwise acceptable. I argue that this complexity may be the source of the relative degradation of the Focus conditions (compared to the Given counterparts) detected in Experiment 5A.

5.2.7 Summary

This section reported the results of a rating experiment designed to address the core question whether focusing an *in situ* universal quantifier affects its scope-taking possibilities in a doubly quantified sentence, either in the way suggested by the Focus Narrow Scope hypothesis (138.a) or in the way held by the Focus Wide Scope hypothesis (138.b). The results show that contrastively (correctively) focused post-verbal universal quantifiers are readily able to take both inverse wide scope and surface narrow scope with regard to a pre-verbal distributive

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numeral indefinite NP, forming part of their background. The same is true of given post-verbal universal quantifiers, located within the background of a focused pre-verbal distributive numeral indefinite NP. The consistently high ratings of all target conditions (as opposed to a control condition), and the lack of a significant interaction of the focus or given status of the universal quantifiers with the targeted narrow or wide scope interpretation in the ratings are squarely at odds with both the Focus Narrow Scope hypothesis and the Focus Wide Scope hypothesis as generalizations about the grammar of scope. Focusing a universal quantifier does not grammatically determine its scope with regard to non-focal (and non-topical) elements in the clause that are contained in its background. The follow-up studies proved that the relative degradedness of the focus condition in Experiment 5 is not due to the non-canonical, post-verbal position of the focused element but it may rather be due the complexity of the focus structure it involves.

DOI: 10.15774/PPKE.BTK.2020.021

6 General Discussion and Conclusions

This chapter is devoted to summarizing the main issues that arose in this thesis and to providing a broader theoretical perspective to the main findings. In the first part, I discuss the findings regarding the role of prosody and information structure in quantifier scope, wrapping up the analysis of doubly quantified sentences (Section 6.1). In the second part of the chapter, I propose a possible resolution of the paradox arrived at the end of the previous chapter: the presence of the disambiguating effect of information structure in the negative sentences of chapter 4, and the absence of a similar effect in doubly quantified sentences in chapter 5 (Section 6.2). Section 6.3 provides a concise conclusion of this thesis.

6.1 Prosody, information structure and quantifier scope

First recall the hypothesis of the Prosodic Approach. In this theory, prosodic form directly determines the scope interpretation of the sentences containing more than one scope bearing operator. This view challenges the classic Y model of the grammar, since besides syntax, it postulates another, direct interface between phonetic form and semantic interpretation. I repeat this modified Y model, introduced in Chapter 1.

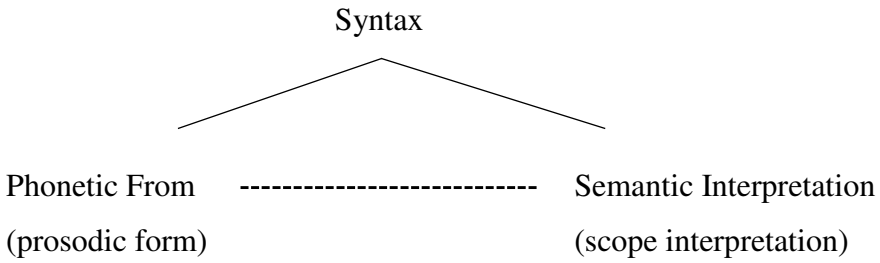

Figure 1. The classic Y-model of the grammar and the Prosodic Approach

This model is supported in principle if we find cases of prosodic differences in the absence of syntactic *structural* differences which are associated with divergent scope interpretations. The research question related to this Prosodic Approach was formulated in (RQ.i.), repeated below:

(RQ) i. Does prosody affect the availability of linear and inverse scope interpretations in doubly quantified sentences?

DOI: 10.15774/PPKE.BTK.2020.021

Experiments 1, 4A and 4B addressed this question.

The second approach considered in this thesis is what I refer to as the Information Structural Approach. For the sake of convenience I repeat this model from Chapter 1.

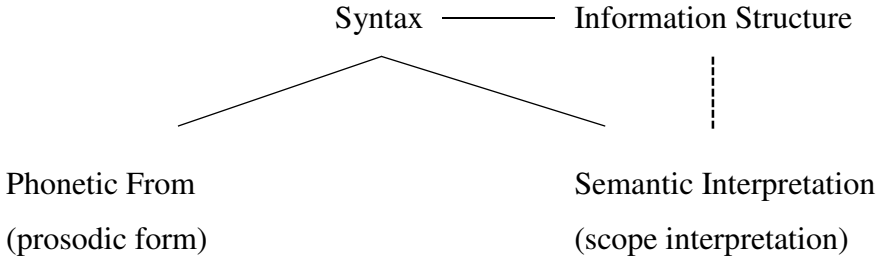

Figure 2. The classic Y-model of the grammar and the Information Structural Approach

This model assumes that scope interpretation is affected by the information structure of the sentence. The particular concern of the present thesis is the potential effect of focus (or given) status on logical scope options. The model would receive support if we found that the focus (or given) status of a quantified NP limited its scope reading with regard to another scope-bearing element to either wide scope or narrow scope. This model is suitable to account for any apparent associations of scope interpretations with prosodic realizations that are in turn linked to information structural differences (while it cannot account for such associations if they turn out to be unrelated to IS distinctions). In such cases it may be assumed that the relevant prosodic differences are due to differences of IS, and it is the latter that is responsible for the scopal effects found.[30] The research question this raises is whether we find scopal oppositions to be linked to prosodic differences that are ultimately due to differences in information structure. This was formulated in (RQ.ii) as follows:

(**RQ**) ii. Does IS mediate between prosodic realization and scope interpretation?

Experiments 4A and 4B, as well as Experiment 5 were designed to address this question.

The last approach considered here is one in which all scopal differences are assumed to be mapped from syntactic structure alone, in the sense that if QP1 scopes over QP2 in one reading and it scopes under QP2 in another reading, then the two interpretations must be syntactically

[30]Recall that here we abstract away from the independent theoretical issue as to whether in any such cases IS affects scope directly, or through syntactically represented formal IS-features. I call the approach an Information Structural Approach even if the latter is assumed.

DOI: 10.15774/PPKE.BTK.2020.021

different in that either QP1 or QP2 (or both) sit in different (overt or covert) syntactic positions in the two readings. Quantifier Raising and reconstruction are two operations that may give rise to such structural differences covertly. This model, referred to here as the Syntactic Approach, is represented in Figure 3.

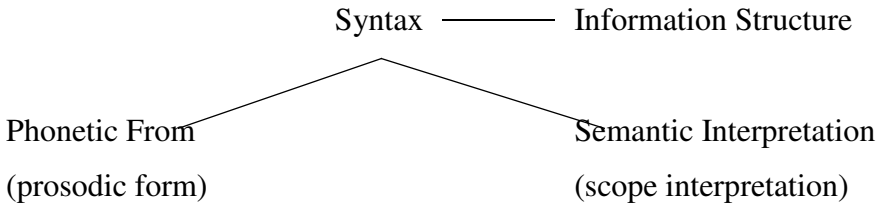

Figure 3. The classic Y-model of the grammar (and the Syntactic Approach)

This approach is more parsimonious than the Information Structural Approach or the Prosodic Approach. For this reason it will have to be selected over them if it turns out that any detected prosody-scope associations or IS-scope associations can be represented as deriving from syntactic differences. The question this raises with particular regard to any IS-effects found was formulated as RQ.iii:

(**RQ**) iii. Is there a syntactic distinction that underlies any IS difference that is responsible for any detected scopal effect?

While all of the experiments presented in this thesis bear on this question, most relevant are Experiments 2 and 3.

6.1.1 Prosody and quantifier scope in null context

Experiment 1 sought an answer to the experimental question formulated in (EQ.i), repeated here for the sake of convenience:

(**EQ**) i. Can prosody disambiguate between linear and inverse scope readings in the absence of context in speech production?

This experiment examined the production of linear and inverse scope interpretations in doubly quantified sentences in order to test whether prosody alone systematically affects scope

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interpretation, and in particular, relations of prosodic prominence. Target sentences contained no topic and no inherently focused or focus-sensitive element, and were presented without a context. **The measured acoustic cues of prosodic prominence relations were not found to exhibit any significant differences across the two scope conditions**. The significant effects found in the control conditions, on the other hand, show that participants properly attended to their task. They were able to link the different depicted interpretations to ambiguous sentences, and they systematically expressed the differences between targeted interpretations using phonetic cues of relative prominence in their production.

From the fact that, in sharp contrast to the control items, no differences emerged across the two scope conditions in the critical target sentences in terms of the acoustic cues of prosodic prominence relations, I conclude that, despite the fact that participants were free to assign any information structure to these decontextualized target sentences, the distinction between the linear and inverse scope readings was not cast as an information structural (specifically, focus structural) difference in their production. In other words, the two scope readings were accessed and expressed without recourse to the postulation of distinct information structures. In particular, there are reasons to believe that the invariant information structure assigned to target sentences is that of a broad focus sentence. First, as pointed out in section 3.1.1 above, target sentences did not contain an aboutness topic. In addition, the data provide evidence that the pre-verbal quantified indefinite NP was not interpreted as a focus either, taking the rest of the sentence as its background.

I conclude that the prosodic effect on scope interpretation is only illusory in the case of doubly quantified sentences. I argue that the pure Prosodic Approach should be revised, since (i) the empirical data from Hungarian did not reinforce this theory (beside Experiment 1 see Gyuris and Jackson 2018) and (ii) there is alternative theoretical machinery that can explain the observations that lead to this prosodic account. Particularly, the Information Structural Approach can handle the data without postulating a direct link between the prosodic form and the semantic interpretation.

6.1.2 Prosody and quantifier scope in information structurally controlled context

Not only the Prosodic Approach but the Information Structural Approach was tested in production studies, since there is an intricate interrelationship between prosody and information structure. Experiment 4A tried to disentangle the roles of these two modules in the case of

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doubly quantified sentences in context. The relevant research question was formulated in (RQ.ii), and implemented experimentally in terms of (EQ.ii.b):

(**RQ**) ii. Does IS mediate between prosodic realization and scope interpretation?

In other words, the prosodic difference only reflects the information structural difference and in this case it is not prosody that determines the scope readings directly. Instead, the different readings and the different prosodic realizations are determined by information structure.

(**EQ**) ii. a. Can two sentences that have identical information structures have different (linear or inverse) scope interpretations, and

b. if so, is this reflected in sentence prosody?

Experiment 4A examined the production of linear and inverse scope interpretations in doubly quantified sentences in order to test whether quantifier scope alone systematically affects sentence intonation, in particular, relations of prosodic prominence, in a way that is independent of, or additional to, the prosodic encoding of information structure. To this end, doubly quantified sentences were placed in different dialogues that served to elicit specific information structural and scope interpretations. In particular, it was varied in topicless sentences whether the numeral of a pre-verbal existential indefinite NP or the quantifier of a post-verbal universally quantified NP functioned as the focus, whose given background was supplied by the rest of the sentence. These two types of information structures were crossed with linear and inverse relative scope interpretations of the two NPs. **Scope interpretation was not found either to have any significant effect on any of the investigated acoustic parameters, or to interact with information structure in determining sentence intonation**. **This outcome suggests that logical scope alone is not expressed in sentence prosody in a way that would go beyond the prosodic realization of information structure.** In general, it is difficult to draw strong conclusions from null hypothesis significance testing if the finding is the lack of an effect. However, this finding of a null effect of scope interpretation is to be juxtaposed to the significant effect displayed by information structure within the same experiment.

Furthermore, these results are convergent with Baltazani's (2002a;b) and Gyuris and Jackson's (2018) similar findings in sentence processing. As noted in Chapter 3, these authors investigated doubly quantified sentences in order to explore the potential influence of prosody on scope interpretation in perception. Although there are several further differences, beyond the

DOI: 10.15774/PPKE.BTK.2020.021

perception versus production perspective adopted, between the design of their experiments and that of the one(s) presented in this thesis, the outcomes of their studies also revealed no significant effect of prosodic prominence relations on the scope interpretations assigned.

At this point, the data maintains the conclusion drawn at the end of Section 6.1.1, namely that the prosodic effect on scope interpretation is only illusionary in the case of doubly quantified sentences. In the next section I turn to the deeper analysis of the role of Information structure on scope interpretation which challenges the Information Structural Approach.

6.1.3 Information structure and scope

Recall that in this account, the information structural status of the scope bearing element determines its scope taking. The second point of the general research question (RQ.ii) repeated above belongs to this issue, and the second subquestion with its first half (EQ.i.a).

While the cases of aboutness topics and contrastive topics are seemingly straightforward, the effect of focus status is less clear. Experiment 5 targeted this very issue and to be more specific, (EQ.iii) encounters the issue of focus and given information structural statuses:

(EQ) iii. a. Keeping information structure constant, does a focused post-verbal quantifier permit only inverse scope or only linear scope with respect to a pre-verbal scope-taking element, or both?

b. Keeping information structure constant, does a given post-verbal quantifier that is part of the background of a focused pre-verbal scope-taking element permit only inverse scope or only linear scope with respect to it, or both?

Experiment 5 investigated the availability of linear and inverse scope interpretations using the same contextually controlled material of Experiment 4 in acceptability judgment paradigm. The results show that contrastively (correctively) focused post-verbal universally quantified NPs (UQP) are readily able to take both inverse wide scope and surface narrow scope with regard to a pre-verbal existential indefinite NP modified by the distributive particle (DistNumP), forming part of their background. The same is true of given post-verbal UQPs, located within the background of a focused pre-verbal DistNumP. The judgments revealed a consistent (purely) pragmatic effect of focus status on quantifier scope, in other words, **keeping information structure constant, the focus or the given status of post-verbal quantifier permits both scopal readings of a doubly quantified sentence.** These results are clearly

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against the view that focus status belongs to either wide or narrow scope reading. As it was enumerated in Chapter 3, many authors assume that focus status is linked to narrow scope reading (e.g. Diesing 1992, Kitagawa 1994, Kratzer 1995, Krifka 2001, Cohen & Erteschik-Shir 2002, Pafel 2006). A number of others, however, have associated focus with wide scope interpretation (Williams 1988; May 1988; Langacker 1991; Deguchi & Kitagawa 2002, Ishihara 2002).

Inverse scope conditions were judged slightly less accessible than linear scope, which phenomenon is quite straightforward and has independent, cognitive reasons, since the inverse reading means more load for the processor in general. Second, post-verbal UQPs receive a somewhat lower rating when they are focused than when they are given, *without an interaction with scope interpretation*. While the first of these effects parallels recurrent findings of earlier cross-linguistic literature, the second finding can be understood in the light of the results of the complementary experiments, Experiment 5B and 5C. Experiment 5C revealed that in the two focus conditions, the information structure was more complex than in the given conditions which resulted in an extra load on the processor that again could be detected with the acceptability judgment paradigm.

From a broader perspective, the finding that focus sharply differs from topic in terms of (the lack of) its effect on scope corroborates approaches that view topic and focus as belonging to two distinct dimensions of Information Structure. Recall that aboutness topic informational structural status is clearly linked to wide scope interpretation, namely aboutness topics scope over the comment part of the sentence (Ioup 1975, Kuno 1982, 1991, Kempson & Cormack 1981, Reinhart 1983, May 1985, Cresti 1995, Erteschik-Shir 1997, Portner & Yabushita 2001, Krifka 2001, Ebert & Endriss 2004).

Although I take the present results to be strongly suggestive, further work is needed to establish to what extent they generalize to other QNP types. It is a well-established observation that the lexical type of quantified NPs affects their ability to take wide scope (Ioup 1975). The doubly quantified experiments involved two kinds of QNPs: universal quantifier phrases and distributive existential indefinite NPs, in *in situ* versus A-bar moved positions, respectively. It is far from impossible that the scope interpretation of different kinds of QNPs is affected by their focus status differently, and similarly, the A-bar-moved versus A-position of particular QNP types may possibly also enter this interaction in divergent ways (on this, see Beghelli and Stowell 1993, Szabolcsi 1997).

My conclusion that focus (and given) status does not determine quantifier scope is clearly in line with the Syntactic Approach that is based on the classic Y model (complemented with IS).

DOI: 10.15774/PPKE.BTK.2020.021

As we found no IS effects on scope in doubly quantified sentences, the theoretical question formulated in (RQ.iii) does not become relevant to this sentence type.

(RQ) iii. Is there a syntactic structural distinction that underlies the IS difference that is responsible for the detected scopal effect? (If so, there is no need for the revision of the extended Y-model in which syntax is the only interface between the prosodic form and the scope interpretation).

At this stage, as far as the investigation of doubly quantifier sentences are concerned, I conclude that there is no need to postulate a direct link between Information Structure and the semantic module, since any attested prosodic differences are due to information structural differences that are orthogonal, and therefore irrelevant, to scopal oppositions. If so, then the restrictive, classic Y model (repeated below in Figure 3.), taking Syntax as the only interface, can be maintained. Before this can be concluded, however, we need to face the paradox encountered at the end of Chapter 4.

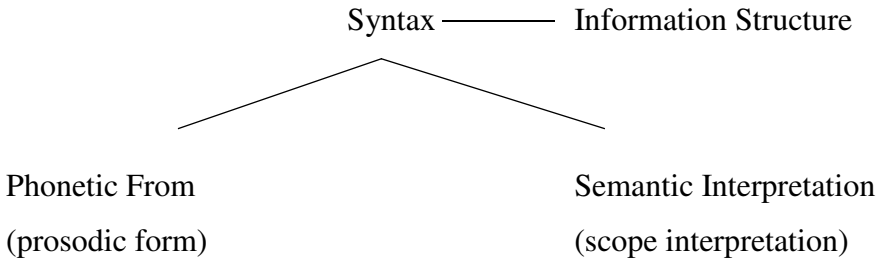

Figure 3. The classic Y-model of the grammar (and the Syntactic Approach)

6.2 The role of information structure in the scope interpretation of negative sentences

This dissertation investigated not only the scope relations of doubly quantified sentences but the scope of quantified NPs in negative sentences as well. At the end of Chapter 4, I left open the question regarding the results of the negative sentences in Experiment 2 and 3. In these experiments the data revealed that different prosodic patterns were associated with the different scope interpretations. I argued in Chapter 4 that the different prosodic patterns, in turn, were related to the distinct distribution of the focus information structural role. This creates a paradoxical situation: while doubly quantified sentences show no association between IS and scope, negated sentences do. This subsection addresses this very paradox.

DOI: 10.15774/PPKE.BTK.2020.021

Two types of negative sentences were involved in production experiments without any contextual control, namely only the scope interpretations were kept in check. The first one contained a post-verbal bare numeral NP (Experiment 2), while the second type had a post-verbal quantifier, *more than one* (Experiment 3). **The prosodic analysis revealed that different prosodic patterns belong to different scope readings in both sentence types**. This, in itself, would be in line with the Prosodic Approach.

As it was mentioned in the Introduction in relation to contrastive topics (Section 1.1), different scope readings may belong to different prosodic forms in negative sentences. Recall the German example in (7), repeated here:

(7) / [$_{QP}$ Alle politiker] sind \ [$_{NEG}$ nicht]korrupt.
all politicians are not corrupt

neutral intonation linear scope

a. 'all politicians are such that they are not corrupt'

hat contour inverse scope

b. 'it is not true that all politicians are corrupt'

(Büring 2014; ex: 21)

As pointed out in the Introduction, one can argue at first glance that in the case of negative quantified sentences the prosody can disambiguate the sentence reading. This would be in line with the Prosodic Approach, although it is clear that in the case of (7) the different prosodic forms mark different information structures as well, where marked prosody is due to the contrastive topic status of the initial constituent. As suggested in Chapter 1 in relation to examples with a contrastively topicalized QP, the fact that this QP takes narrow scope can be captured through syntactic reconstruction of the QP back to its base- (or other A-)position, thereby making the Syntactic Approach tenable.

I argued in sections 4.1.2.4 and 4.1.3.4 that in the negative sentences the different prosodic patterns, in turn, do not merely reflect distinct scope readings but they are related to distinct information structural interpretations. If correct, this hypothesis brings the negative sentences examined in this thesis in line with the Information Structural Approach.

Because of the characteristic of the experimental design, Experiment 2 and 3 did not control the information structure of the sentences, although participants arguably distinguished the two readings with two different prosodic realizations that may be traced back to two different information structures, namely that the (prosodically prominent) focused operator takes wide

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scope over the (prosodically less prominent) operator that sits in the given part of the sentence. First, I focus only on the sentence type called Neg vs. QP (113). At the end of Section 4.1.3, I argued that the above mentioned two information structures are defined by distinct QUDs as follows:

(113) *Nem romlott el több mint három nyomtató.*
no broke VM more than three printers
'No more than three printers broke down.'

(120) a. Did more than three printers break down? Linear scope reading: Neg > QP
b. *Nem romlott el több mint három nyomtató*
not broke VM more than three printer
'No, no more than three printers broke down.'

(121) a. How many printers did not break down? Inverse scope reading: Neg < QP
b. *Nem romlott el több mint három nyomtató*
not broke VM more than three printer
'There were more than three printers which did not break down.'

The prosodic and associated scope taking patterns were much the same in the case of sentences in which the negated sentence contained a distributive bare numeral NP instead of a quantifier in the post-verbal field. I related the two scope options to two distinct QUDs in a way parallel to (120–121).

My generalization was that prosodically prominent focus takes wide scope over its prosodically non-prominent background, in line both with predictions of Hunyadi's (2002) prosodic account and with the information structural generalization that focus information structural status belongs to wide scope interpretation (see Chapter 1). More specifically, in (120) what is informationally new and answers the QUD, and in this sense functions as the focus, is the negative operator, while in (121), the relevant QUD is answered by the focused QP. At first glance, then, it would seem that ultimately the focus information structural status determines the scope relations in these negative sentences.

By contrast, as the results showed in Chapter 5 with regard to doubly quantified sentences, if all of the logical possibilities of the information structural status and scope readings are taken into account, the focus information structural status does not determine the scope of the scope

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bearing element. Namely, I found that in the investigated doubly quantified sentences the focused element took either wide or narrow scope, and the same was true for the backgrounded scope bearing elements as well.

At this point the puzzle appears to be as follows:

(145) The information structural focus status of a post-verbal quantifier determines its scope taking behavior only in a negative sentence with a single quantified NP, but not in (non-negated) doubly quantified sentences.

One may note that the post-verbal element in (one subset of) the negated sentences in Experiment 3 was a QP containing the modified numeral 'more than n', as opposed to the universal QP that appeared in doubly quantified sentences of Experiment 4. This difference is unlikely to be responsible for (113) because Hungarian '*more than* n' QPs behave similarly to universal QPs in their scope taking if they get an only distributive reading in DistP (Szabolcsi 1997, É.Kiss 2002; see Section 2.2.4). Another difference is that the focus types are not identical in the two (sets of) experiments, namely in Experiment 3 the focus was new information focus, while in Experiment 4 it was corrective focus (although in neither case was the focus identificational, É. Kiss 1998). Recall from Chapter 3 that only Erteschik-Shir (1997) differentiates between the focus types regarding the scopal reading, on the basis of contrastiveness: while non-contrastive focus is related to narrow scope, contrastive (a subtype of contrastive foci are corrective foci) focus triggers wide scope. The results of Experiment 4 do not reinforce this assumption, since both of the scope readings were available in this experiment. Data from Experiment 2 and 3 suggest that the non-contrastive focus takes wide scope in spite of Erteschik-Shir's assumption.

Below I argue that despite appearances the focus status of a quantified NP does not determine its scope taking behavior even in the negative sentences of Experiment 3: that wide scope is associated with focus status itself is illusory. I argue that all of the information structural conditions that could logically emerge cannot be realized in Experiment 2 and 3. The reason is that no QUD can be formed regarding two of the conditions. In one of them the interrogative operator cannot take the widest scope which results in an ill-formed question. While in the case of the other defective QUD, an individuum type variable should cross the negation, although negation behaves as a weak island (Szabolcsi--Zwarts 1993, 1997) for these expressions. In order to make this point, let us return to Experiment 4 in which there were four conditions belonging to the four possible combination of the IS status and scope readings:

DOI: 10.15774/PPKE.BTK.2020.021

(146)

	Given	**Focus**
Narrow	Giv.Nar	Foc.Nar
Wide	Giv.Wid	Foc.Wid

In the case of doubly quantified sentences, it was clear that all of the four conditions have available and plausible four QUDs. The table in (147.a–d) enumerates the **possible QUD**s to each condition with respect to the status of the post-verbal universally quantified NP: note that there is no canonical theory of QUDs regarding their constraints and well-formedness, therefore I use paraphrases here.

(147) **a. Given – Narrow:**

What is the number n such that there are n singers that sang each melody?

b. Given – Wide:

What is the number n such that for each melody there are n singers that sang it?

c. Focus – Narrow:

What is the number n such that there are four singers that each sang n melodies?

d. Focus – Wide

What is the number n that there are n melodies each of which is such that there are four singers that sang it?

e. Target sentence

Négy előadó	*is*	*el-énekelte*	*mindegyik*	*melódiát*.
four singer	DIST.PRT	VM-sang	each	melody.ACC

'Four singers sang each melody.'

In a similar vein, (148) shows the same paradigm for the negative sentences in Experiment 4:

DOI: 10.15774/PPKE.BTK.2020.021

(148) **a. Given – Narrow:**

[OK]Is it true that there are more than three printers that broke down?

b. Given – Wide:

#There are more than three printers such that: ***is it true*** *that there are more than three printers that broke down?*

c. Focus – Narrow:

#What is the number n such that it is **not** true that there are **n printers** that broke down?

d. Focus – Wide

[OK]**What is the number n** such that **there are n printers** that did **not** break down?

e. Target sentence

Nem romlott el több mint három nyomtató.
no broke VM more than three printers
'No more than three printers broke down.'

I assume that although the experimental, ambiguous negative sentences are well-formed, I argue that two of the (logically) possible QUDs are not licensed. Considering each case the following turns out. The case is clear when the given quantifier takes narrow scope, the negative particle is focused and takes wide scope over the rest of the sentence (148.a). The other clear-cut condition is when the focused quantifier takes wide scope over the backgrounded negation (148.d). The two intricate cases are (148.b and c). In (148.b) the given quantifier takes wide scope over the negation which is focused. The corresponding QUD is a yes-no question just like the one presented in (148.a), although in this case – because of the wide scope of the QP in the target sentence – the interrogative operator does not take maximal scope which is a requirement of a well formed question (otherwise the sentence is not a question), it seems that this general requirement holds for QUDs as well. I argue that although (148.c) is a logically possible condition as well, it cannot be generated in a syntactic (structural) sense. In the target sentence, the focused quantifier should take narrow scope with respect to the backgrounded negative particle. The corresponding QUD construction (148.c) shows a weak island effect because the interrogative operator alone cannot cross negation, leaving behind its restriction.

DOI: 10.15774/PPKE.BTK.2020.021

Because only QUDs (148.a and d) are available and they belong to two, (prosodically) distinctively realized target sentences, two interrelated illusions occur. At first glance it seems that prosody alone can differentiate between the two readings, since the two scope readings are realized in two prosodic forms. However, a detailed investigation can reveal that the two prosodic realizations reflect the focus structure of the sentences. At this point one can argue that the focus information structural status *per se* determines the scope reading of an operator. In this section, I led the argumentation further and showed that this latter one was just an illusion as well. I based my argumentation on the independent results from my experiments that investigated doubly quantified sentences in controlled information structures. I conclude that not all the logically possible information structural conditions can be formed but the two which have very different focus structures and hence distinct prosodic realizations. That is the source of the illusions attested in Experiment 3 and I analyze results of Experiment 2 in the same fashion. The only difference was between Experiment 2 and 3 is the post-verbal quantified NP. In Experiment 2 the quantified NP was an indefinite NP modified with a bare numeral. I assume that the paradigm of the QUDs is defective in the same way as it was shown for Experiment 3.

All in all, I argue that neither prosody, nor information structure (more precisely, the focus status) have a direct effect on quantifier scope reading. The real mechanism underlying this phenomenon is that two of the QUDs cannot be formulated in the case of negative sentences. The same does not occur in the doubly quantified sentences investigated in this thesis. This is the reason why they do not exhibit a correlation between their prosody and scope interpretation. An important repercussion of the analysis presented in this section is that QUDs seem to have to obey conditions that otherwise regulate natural language questions. In this manner QUDs are not unrestricted. In this sense, the information structural difference that is found to have a direct effect on quantifier scope taking can be captured at the interface of syntax and information structure, namely, QUDs. The information structural differences responsible for scope differences in Experiments 2 and 3 are not located in the target sentences themselves but in the syntactically represented QUD that the sentences are associated with.

Assuming that the licensing of QUDs in relation to sentences concerns the mapping between syntax and information structure, the relation between QUDs and scope relations is mediated through narrow syntax. The information structural component checks whether the sentence is congruent with the QUD. Checking congruence needs to include a representation of scope relations. As scope relations are inevitably specified as part of the QUD, the QUD can affect the scope interpretation of a sentence that is congruent with it. It is in this manner that QUD

DOI: 10.15774/PPKE.BTK.2020.021

plays a role in determining possible scope readings. According to this picture, it is not the focus or given status itself that affects scope, but the specification of scope in the QUD.

These findings suggest that no departure from the classical Y model of the grammar is needed, and therefore the Syntactic Approach of quantifier scope can be maintained. The Y model is then preferred because of its restrictive nature: it keeps the phonetic form and the semantic module separate, having no direct interface, and it also lacks a direct mapping between focus/givenness and logical scope.

6.3 Conclusions

This section summarizes the conclusions of the experimental studies presented in this thesis. The main findings of the five main experiments (supplemented with additional four minor studies) can be distilled into the core claims listed in (149–151).

(149) Prosody alone does not disambiguate between different possible scopal readings of (upward monotonic distributive) quantifier phrases.

(150) When prosody appears to correlate with two different possible scopal readings of a(n upward monotonic distributive) quantifier phrase, then the prosodic distinction reflects an underlying information structural difference.

(151) The information structural focus versus given status of a scope bearing element does not determine its logical scope.

From a theoretical perspective, these results favor Syntactic Approach to quantifier scope and the classical Y model of grammar, which keeps the semantic and the phonetic modules of the grammar separate, without a direct interface. Furthermore, the findings suggest that there is no need to posit a direct interface between the information structural component and scope interpretation either.

The thesis also contributes to the theory of QUDs. It argues, based on the analysis of the relation between scope and information structure in negated sentences that QUDs have to fulfil requirements that are imposed on natural language questions.

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ÖSSZEFOGLALÓ – ABSTRACT IN HUNGARIAN

Az (1)-hez hasonló mondatok, amelyekben egynél több hatókörrel bíró elem szerepel, potenciálisan kétértelműek. (1)-ben ez a két elem két kvantorkifejezés (QP1, QP2), amelyek hatóköri interakciója két olvasatot enged meg: a felszíni mondatszerkezetnek megfelelő, egyenes olvasatot (1.a) és az ahhoz képest fordított hatóköri olvasatot (1.b).

(1)[$_{QP1}$ Négy író is] lefordította [$_{QP2}$ mindegyik művet].

a. ‘Négy olyan író is volt, aki mindegyik művet lefordította.’ QP1 > QP2

b. ‘Mindegyik mű olyan, hogy (egyenként) négy író is lefordította.’ QP1 < QP2

Számos olyan tényező ismert, amely befolyásolhatja a több kvantort tartalmazó mondatok logikai hatókör értelmezését. Ilyen többek között például a hatókörrel bíró elemek szemantikai típusa mellett a szórend, a kiinduló mondatszerkezet, az intonáció, az információszerkezet, illetve a világismeret. A magyarban a – kontrasztív topikot nem tartalmazó mondatok közül – azok a mondatok lehetnek kétértelműek, amelyekben legalább az egyik kvantor az ige mögött áll a felszíni szerkezetben.

A disszertáció azt a kérdést vizsgálja, hogy pontosan mi a szerepe a logikai hatókör meghatározásában a felsorolt tényezők közül a prozódiának és az információszerkezetnek: Szisztematikusan hatnak-e ezek a tényezők a hatókörértelmezésekre, és amennyiben legalább részben igen, akkor ez a hatás közvetlenül érvényesül-e, vagy csak közvetett módon, a szintaxison keresztül?

Az elméleti megközelítéseket három nagy típusba lehet sorolni. (i) A Prozódiai Megközelítés (PM) a mondat prozódiai viszonyaiból kiindulva vezeti le a lehetséges hatóköri olvasatokat, mely prozódiai viszonyokat lexikai és információszerkezeti tényezők is befolyásolhatják. (ii) Az Információszerkezeti Megközelítés (IM) szerint a mondat információszerkezete, ezen belül különösen a kvantor információszerkezeti szerepe határozza meg az elérhető hatókör-értelmezéseket, függetlenül a mondat szintaktikai szerkezetétől. Végül a (iii) Mondattani Megközelítés (MM) a mondat szerkezetéből, közelebbről a k-vezérlési viszonyok alapján vezeti le a hatókört. Ezen megközelítések közül az első kettő eltér a generatív nyelvtan Y-modelljétől, amelyben a szintaxis az egyetlen közvetítő a két értelmező modul, a fonetikai forma (itt: a prozódiai megvalósítás) és a szemantikai reprezentáció (itt: a logikai hatókör-értelmezés) között. A PM egy további, közvetlen kapcsolatot feltételez e két utóbbi értelmező modul között, az IM pedig közvetlen kapcsolatot lát az Információszerkezeti

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viszonyok és a hatókör-értelmezést kódoló szemantikai modul között. Végül a MM a klasszikus Y-modellt képviseli, amennyiben a szintaktikai szerkezetet tartja az egyetlen közvetítőnek.

A fenti kutatási kérdéseket kísérletes módszertannal vizsgáltam magyar adatok alapján. Egyszerre tanulmányoztam az prozódia, az információszerkezet és a szintaxis viszonyát (1)-hez hasonló két kvantoros, valamint tagadó mondatokban. A bemutatott kilenc kísérlet közül négy beszédprodukciós, egy beszédpercepciós, és négy elfogadhatósági ítéleteken alapuló kísérlet volt. Három kísérletben képi stimulusok és kontextus segítségével egyszerre kontrolláltam az ige előtti és mögötti QP információszerkezeti szerepét és hatókörértelmezését.

Eredményeim azt mutatják, hogy (i) a poszt-verbális kvantor fókusz illetve adott szerepéhez mind a szűk, mind a tág hatóköri olvasat társítható, amennyiben információszerkezetileg mindkét hatóköri olvasatban a kongruens mögöttes kérdés engedélyezett, így a (fókusz/adott) információszerkezeti szerepnek önmagában nincs hatása a kvantor hatókör-értelmezésére. (ii) Az azonos információszerkezetű egyenes és fordított hatóköri olvasatú mondatokban a prozódia nem egyértelműsíti a hatókörértelmezést. (iii) A prozódiában kifejeződő hatóköri egyértelműsítés csak akkor valósul meg, ha a két hatóköri olvasat két különböző információszerkezettel jár együtt. Amellett érveltem, hogy ezek a tagadó mondatokban jelentkező esetek modellezhetők anélkül, hogy közvetlen kapcsolatot feltételeznénk a fonetikai forma és a szemantikai modul között, mint a Prozódiai Megközelítésben, illetve anélkül, hogy a szemantikai modul és az információszerkezet között tételeznénk fel közvetlen összefüggést, mint az Információszerkezeti Megközelítésben. Az ilyen mondatok hatókörértelmezése és információszerkezete közötti viszonyban központi szerepet játszik a vonatkozó irodalomban elvontnak gondolt mögöttes kérdés (Question Under Discussion) engedélyezésének folyamata, amelynek – állításom szerint – ugyanolyan szerkezetfüggő megszorításoknak kell engedelmeskednie, mint amilyeneknek a természetes nyelvi kérdéseknek is. Amellett érvelek, hogy ez indirekt módon a szintaxis központi szerepére világít rá, amely összhangban van a Mondattani Megközelítéssel és tágabb értelemben a klasszikus Y-elmélettel.

A disszertáció eredményei arra engednek következtetni, hogy a vizsgált két kvantort tartalmazó és tagadó mondatok adatai alapján a prozódiának és az információszerkezetnek a kvantorhatókör-értelmezésben játszott szerepének megértéséhez nincs szükség arra, hogy eltérjünk a tekintetbe vett versengő megközelítések közül legparszimonikusabb Szintaktikai Megközelítéstől, illetve tágabban: a grammatika Y-modelljétől.