

Information structure in linguistic theory and in speech production: Validation of a cross-linguistic data set

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The aim of this paper is to validate a dataset collected by means of production experiments which are part of the *Questionnaire on Information Structure*. The experiments generate a range of information structure contexts that have been observed in the literature to induce specific constructions. This paper compares the speech production results from a subset of these experiments with specific claims about the reflexes of information structure in four different languages. The results allow us to evaluate and in most cases validate the efficacy of our elicitation paradigms, to identify potentially fruitful avenues of future research, and to highlight issues involved in interpreting speech production data of this kind.

Key words: cleft constructions, clitic doubling, de-accenting, focus position, presentational constructions, scrambling, topicalization

1 Preliminaries

This paper investigates the empirical results observed in a subset of the speech production data that have been obtained through the experiments included in *Questionnaire on Information Structure*. Although data has also been obtained in a number of relatively under-researched languages, the purpose of this paper is to explore the results in languages for which the reflexes of information structure are comparably well documented: French, Greek, German, and Hungarian. This comparison between our results and the literature allows us to evaluate and validate the experimental paradigms implemented during data

¹ This paper is a product of the project D2 “Typology of information structure” which is part of the *Sonderforschungsbereich* “Information Structure”, University of Potsdam & Humboldt University Berlin (sponsored by the German Research Foundation, DFG). The paper evolved through the work on the data set obtained by this project and reflects the analyses made in common with Gisbert Fanselow, Caroline Féry, Manfred Krifka, and Malte Zimmermann.

collection. In addition we identify issues specific to the type of data collection techniques involved, which we and other researchers need to be aware of when assessing the results of the *Questionnaire on Information Structure* in less well researched languages.

The *Questionnaire on Information Structure* (hereafter, QUIS) is designed for the investigation of information structure from a typological perspective. It provides a tool for fieldworkers for collection of natural linguistic data, both spoken and written. The aim is to facilitate the elaboration of grammars of information structure in genetically diverse languages and to allow for typological comparison on the basis of parallel datasets created with identical means.

The core of QUIS is a set of 29 experimental tasks which use visual stimuli (pictures and short films) to manipulate discourse conditions that are known to have an impact on information structure. These tasks together with an accompanying language profile questionnaire and a set of translation-based tasks are published in a reference manual (Skopeteas et al 2006). The Reference Manual and additional materials for use of QUIS in the field are available to the linguistic community via the QUIS website.

As a general principle, the production experiments that are included in QUIS are ‘straightforward’ implementations of the discourse conditions at issue. What is meant by ‘straightforward’, is that we have applied exactly the contexts that are used in the theoretical literature in the setting of production experiments. For instance, an ‘all-new’ context is implemented experimentally in the most obvious way, by showing a picture to the informant and asking the question ‘*what happens?*’. This is exactly the context that the theoretical literature uses in order to make generalizations about sentential form in the all new condition. The difference in our production data corpus is, of course, that it contains semi-spontaneous answers to this question and not judgments based on speakers’

intuitions about the optimal sentence form for this context. Similarly, an agent-given context is established by presenting a picture sequence in which the agent referent appears in the sequence prior to the target sentence. As we shall see below, this type of implementation of discourse conditions has the advantage of having a direct correspondence to the claims in the literature, but the disadvantage that components of the experimental setting or procedure may intervene and introduce unwanted or unexpected effects.

The following sections are devoted to different subjects in different languages: French presentational constructions (see 2); German scrambling and topicalization (see 3); German intonational patterns (see 4); Greek clitic doubling (see 5); and the Hungarian focus position (see 6). Although largely unrelated issues in syntax and phonology are treated, each section follows the same pattern: i) hypotheses from the literature regarding language-specific reflexes of information structure are set out; ii) the results observed in that context in our dataset are described, and discrepancies are discussed.

2 French: Presentational constructions²

2.1 Hypothesis

It has been argued that spoken French obeys a constraint by which focus is dispreferred in preverbal position (see Lambrecht 1994, 2001). This constraint predicts that whenever the subject is part of the focal information of the sentence, the use of a canonical SVO sentence is avoided. Since subject-verb inversion is not possible in French, the only alternative available to satisfy this constraint is to use a bi-clausal construction. Different types of bi-clausal constructions occur in these contexts as it is exemplified in (1) and (2).

² The data from Quebec French has been collected, transcribed and evaluated by Alain Thériault in cooperation with the project D2.

(1) Context:

‘Why are you walking so slowly?’

Answer (French):

J’ai mon pied qui me fait mal.

(lit. trans.) ‘I have my foot that hurts me.’ (Lambrecht 2001: 487)

(2) Context:

‘How do you know?’

Answer (French):

C’est Huma qui me l’a dit.

(lit. trans.) ‘It is Huma that told it to me.’ (Lambrecht 2001:490)

Here we will examine the effects of this constraint in ‘all new’ contexts. According to Lambrecht (2001), the construction which occurs in this context in spoken French is a ‘sentence focus cleft with presentational eventive function’.

(3) (a) Y a mon prof qui n’arrive pas à expliquer l’emploi des clivées.

‘It is my professor who does not manage to explain the use of clefts.’

(b) Mon prof n’arrive pas à expliquer l’emploi des clivées.

‘My professor does not manage to explain the use of clefts.’

(Lambrecht 2001:508)

Thus, we expect that ‘all new’ contexts will induce bi-clausal constructions of the kind presented in (3a), while the corresponding mono-clausal construction in (3b) is suboptimal according to the constraint against preverbal focus.

(4) Hypothesis:

In French, ‘all new’ contexts will trigger presentational constructions.

Unfortunately, there are no previous quantitative empirical studies that directly address the predictions of the constraint on preverbal focus. Two corpus works on spoken French may be considered as indirect evidence for the constraint (cited from Lambrecht 1984): François (1974) finds 46 subject NPs, among

1440 NPs in his corpus, which implies a preference for avoiding lexical NPs in subject position, and similarly Jean Jean (1981) finds that only about 2.5% of the subjects in the corpus are full NPs. Neither study considers the factor of context, i.e. that the subject NPs counted in these corpus queries might also be topical NPs.

2.2 Results

The production experiments included in QUIS have been collected in Québec French. All experiments were performed orally, hence the resulting data is assumed to provide evidence for the variety of spoken Québec French. The data we discuss in this section has been spontaneously produced by four young speakers (two men, two women, age range: 16-20). There are no previous accounts about a dialectal difference which could affect the application of the constraint on preverbal foci in spoken Québec French, thus – as a working hypothesis – we maintain the hypothesis about this constraint as presented in section 2.1 about European French.³

We will first discuss data from two tasks that elicit picture descriptions. The task ‘Eventives’ of QUIS is dedicated to the elicitation of ‘all new’ picture descriptions (total of descriptions obtained: 11). The instructor presents a picture to the informant and asks a question that does not insert any part of the stimulus into the common ground: *What happens?* The task ‘Visibility’ elicits descriptions of picture sequences. The instructor presents two pictures that represent a small story one after the other to the informant. The first picture description is assumed to induce an utterance in an ‘all-new’ context (total of descriptions obtained: 57).

Of the 68 descriptions collected, two were classified as “other”, since they

³ Project D2 is currently creating a parallel data collection in European French, in order to determine whether the observations in Québec French result from a dialectal difference.

include an explicit mention of the speaker (“on voit que...”). Some further sentences contain definite NPs, which suggests that the informant assumes that the entity in the stimulus is part of the implicit common ground he is sharing with the instructor (see illustration in (5)).

- (5) (a) Le chat est dans l’eau.
 ‘The cat is in the water.’
 (b) L’homme marche.
 ‘The man is walking.’

In other descriptions, the informant introduces the referent with only an existential sentence (see illustration in (6)).

- (6) (a) Y a une corde.
 ‘There is a rope.’
 (b) Y a un chien.
 ‘There is a dog.’

The remaining subset of descriptions is the dataset in which we can test the hypothesis in section 2.1. If the speaker does not assume that the referent is part of the implicit common ground (as in (5)) and if the speaker decides to convey more than the existence of the entity (in contrast to (6)), then – according to the constraint on preverbal foci – we expect a presentational construction to be produced.

The data obtained through picture descriptions provide partial evidence about the constraint on preverbal foci. Out of 48 descriptions that are valid for the hypothesis at issue, 16 sentences instantiate the predicted construction (see (7a-b)), and 32 sentences contain indefinite subjects (see (7c-d)) which were expected to be banned by the constraint on preverbal foci in spoken French.

- (7) (a) C’est un musicien qui joue de son instrument.
 ‘It is a musician that plays his instrument.’

-
- (b) Y a une femme qui est en train de marcher.
'There is a woman that is walking.'
 - (c) Un petit garçon coupe un arbre.
'A small boy cuts a tree.'
 - (d) Un homme marche.
'A man is walking.'

The overall data pattern obtained is summarized in Table 1. For validation of the experimental manipulation of “all new” contexts, two measurements have to be considered: (a) to what extent did the experimental manipulation succeed in creating a dataset in which hypotheses about the encoding of propositions in the “all new” context may be tested? (b) to what extent does the targeted data set correspond to the predictions of the previous literature on French?

In answer to (a), the relevant subset for hypotheses concerning the encoding of propositions in “all new” contexts contains the sentences in which speakers do not assume that the referents are part of the common ground and in which they do not simply assert the existence of an entity. Our experimental manipulation succeeded in generating a dataset which allows testing of the targeted hypothesis in 70.5% of the total obtained data (i.e. 48 out of 68 sentences). With respect to (b), namely the prediction that this context will induce presentational constructions in French, our dataset provides evidence that French speakers choose the target construction in a third of the times they produce an ‘all new’ sentence.

Table 1: French data obtained in intended “all new” contexts⁴

total		68					
other		2/68					
	S assumes that referents are part of the CG	7/66					
	S only asserts the existence of a referent	11/59					
	<table border="1"> <tr> <td> <table border="1"> <tr> <td>categorical sentences</td> <td>32/48 (66.6%)</td> </tr> <tr> <td>✓ presentational constructions</td> <td>16/48 (33.3%)</td> </tr> </table> </td> </tr> </table>	<table border="1"> <tr> <td>categorical sentences</td> <td>32/48 (66.6%)</td> </tr> <tr> <td>✓ presentational constructions</td> <td>16/48 (33.3%)</td> </tr> </table>	categorical sentences	32/48 (66.6%)	✓ presentational constructions	16/48 (33.3%)	
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The result in Table 1 confirms the theoretical account of Lambrecht (1994, 2001). Presentational constructions were indeed induced in the condition which is assumed to induce them, and it should be added that presentational constructions were elicited predominantly in all-new contexts in QUIS. However, our results contain a substantial proportion (66.6%) of sentences which are predicted to be suboptimal following Lambrecht’s account (1994, 2001). Even if the constraint on preverbal focus is not categorical, the amount of categorical sentences is high, hence we wonder if the proportions in our corpus are representative of the spontaneous communication or alternatively if they have a strong influence of the used experimental setting, namely the picture description task.

We are able to address this question using QUIS, because data from other tasks within QUIS suggest that there is a difference between picture description tasks and story telling tasks. In story telling tasks, speakers were shown a picture series which presents a short story, then were asked a question which induces a short spontaneous narrative concerning the presented pictures. The first sentence of the produced narratives in these tasks is always a presentational construction, as exemplified in (8) and (9):

⁴ In this and following tables, grey cells contain the subset of the dataset which is valid for testing of the targeted hypothesis. Constructions which are predicted by the hypothesis are marked by ‘✓’.

(8) Qu'est-ce qui s'est passé ?

'What has happened?'

Il y avait un garçon sur la branche de cet arbre. Il est tombé et s'est fait mal au genou.

'There was a boy on the branch of this tree. He fell and hurt his knee.'

(9) Pourquoi tout le monde est attroué? Qu'est-ce qui s'est passé ?

'Why are all these people here? What has happened?'

Y a eu un face à face entre deux voitures et les deux voitures ont pris feu.

'There was a crash between two cars and the two cars caught fire.'

This story-telling task does not elicit enough data to allow for quantitative generalizations to be made. However we suggest that, if confirmed in a larger dataset⁵ this pattern indicates a difference between 'narrative-first' contexts and picture descriptions: a picture description can induce a categorical structure that directly corresponds to the perceived event, whereas in a narrative-first sentence the speaker is more likely to choose a structure designed to introduce a new referent or referents.

If this nuance between the two contexts is accurate, then it may be appropriate to propose a minor modification in the definition of the discourse conditions which are expected to trigger presentational constructions in French: at the very least it suggests that the constraint on preverbal foci may be violable in specific contexts such as the picture descriptions which motivate the preference for categorical sentences. This will go hand in hand with the fact that clefting is not the only possibility to express focus on preverbal subjects in French, since it has been shown that this is also possible through phrasing. Féry (2001) reports the results of an experiment in which speakers were instructed to

⁵ The project D2 in cooperation with Alain Thériault is in the process of carrying out a further data collection in QF using the manipulations that are hypothesized to be relevant, with a larger group of speakers.

answer to questions in a natural way using canonical sentences written on cards. Of course, the stimulus here has a strong priming effect on the produced sentences. But if a SVO sentence was categorically banned in an ‘all-new’ context, we would expect at least some impact on the spontaneous reformulation of the stimulus by French speakers. The proportion of spontaneously produced clefts was relatively low (0.05%), which suggests that the use of categorical sentences in ‘all new’ contexts is a possible option.

(10) Que ce passe-t-il à la cuisine?

‘What is happening in the kitchen?’

[_F Le marmiton caramélise les navets].

‘The cook is caramelizing the turnips.’ (see Féry 2001)

2.3 Summary

In the French dataset, we tested the hypothesis that ‘all new’ contexts induce presentational constructions as a result of a constraint on preverbal focused constituents in this language according to Lambrecht (1994, 2001). Experiments that aim to elicit ‘all new’ utterances on the basis of picture descriptions provide partial confirmation of this hypothesis: they succeeded in inducing presentational constructions at 33.3% of cases. However, the high proportion of categorical sentences obtained in this discourse condition was surprising. Data from tasks that induce a narrative suggest that presentational constructions are almost exclusively chosen in an ‘all new’ context when speaker’s task is to produce a whole narrative, and not only to describe the presented stimulus.

The common means to illustrate the sentential form of a language in pragmatically neutral conditions is to give it as an answer to a ‘what happens?’. This practice is widely used in grammars and linguistic essays. In this sense, to present to the informant a scene through a stimulus and to ask ‘what happens?’ is probably the most straightforward way to implement the ‘all new’ context in a

production experiment. However, our data implies that the description of a presented stimulus may not be the most appropriate discourse situation in order to elicit an ‘all new’ sentence.

3 German: Scrambling and Topicalization⁶

3.1 Hypothesis

German is a verb-second language, which is analyzed as movement of the finite verb to the C° head position. Consequently, every preverbal constituent in main clauses is analyzed as occurring in the Specifier position of CP. In this view then, OVS word order in main clauses is a form of A-bar movement. The information structural conditions that license such a movement can be narrow focus or topicalization of the object constituent (see Frey 2004, 2006; Jacobs 1997; 2001). Perception experiments carried out within the SFB 632 show that the use of a OVS order has the effect that the addressee anticipates a new referent for the subject constituent (Weskott et al. 2006). In contrast to the preverbal constituents, the order of the postverbal ones is determined by scrambling. In this case, the order of constituents is determined by pragmatic constraints, such as the animate-first or given-first effects (cf. Fanselow 2001, 2003, 2004; Grewendorf & Sabel 1994; 1999; Haider 2006; Haider & Rosegren 2003).

These observations about German syntax will be shown below to hold in the D2 dataset. The following predictions about word order result from the structural distinction between scrambling and topicalization.

(11) Hypothesis I:

⁶ The German data has been collected, transcribed, and evaluated by Anja Arnhold, Kathi Moczko, and Andreas Pankau. Special thanks are due to Andreas Pankau who has recapitulated the theoretical background on scrambling and topicalization in German for this paper.

Contexts inducing topicalization license OVS in German.

(12) Hypothesis II:

Simple asymmetries of discourse status (subject=new & object=given) license XVOS, but not OVS.

3.2 Results

Qualitative observation of the obtained data confirms the hypotheses presented in 3.1. In the experiment “Who does what?” the informant is shown a picture that presents two parallel events. Then the instructor asks him a question which induces an answer with contrastive topicalized object constituents as illustrated in (13). This example confirms Hypothesis I.

(13) Question:

‘Who is looking at the hammer and who is looking at the pot?’

Answer:

Der Mann schaut den Hammer an und den Topf schaut die Frau an.

‘The man is looking the hammer and the woman is looking the pot.’

Scrambling is induced through manipulation of discourse status, as for example in the following picture description (experiment “Changes”). There are no examples of topicalization in this experiment as predicted by Hypothesis II.

(14) [pict. 1] Ein Junge schiebt einen Tisch...

‘A boy is pushing a table...’

[pict. 2] Ja, und danach schiebt eine Frau diesen Tisch auch weiter...

‘...yes, and afterwards a woman pushes this table further...’

[pict. 3] Dann schiebt den Tisch ein Mann.

‘...then, it is a man that pushes the table.’

Instances of scrambling have been elicited in contrastive topicalization too. This is illustrated in (15) which has been elicited through the experiment “Groups”. In this experiment, the informant describes two pictures: in the target picture,

which is the second one, the patient constituents are given information (they are already introduced through the description of the first picture).

(15) [pict. 1] Zwei Stifte und drei Pfannen stehen auf dem Boden.

‘Two pencils and three pans are on the floor...’

[pict. 2] Jetzt nehmen drei Kinder die drei Pfannen auf... in die Hand und die beiden Stifte nehmen die Frauen in die Hand.

‘...now three children take the three pans... in the hand and the women take both pencils.’

In the data elicited through QUIS we found single examples that are in accordance with the grammatical facts of German as summarized in 3.1. However, in a quantitative view the sample of spoken German which has been created through QUIS does not correspond with the available knowledge about the frequency of OS sentences in German: we elicited only 10 OS sentences in a total of 1455 sentences with lexical subject and object constituents (0.006%). This result deviates strongly from previous corpus findings (Weber & Müller 2004 found 3% OVS sentences in the NEGRA corpus of German newspapers). This result suggests that the data sample that we have obtained for German is not representative of the properties of spontaneous speech production in this language.

A possible explanation is that the problem lies in the experimental methods used to induce scrambling and topicalization in German: the discourse manipulations in the experimental context did not succeed in establishing the properties of the common ground that were intended in the experimental design. We can explore this hypothesis by looking at the referential status of arguments in the data. The data presented in Figure 1 and Figure 2 summarize the results on the referential status of arguments in the experiment “Changes”, which elicits descriptions of picture sequences. The first picture induces an ‘all new’ description, and the subsequent pictures induce descriptions in which either one

argument or the verb is new information and the rest of the sentence is given (=identical with the previous picture). 132 sentences were obtained in each experimental condition.

The result shows that in the ‘all new’ description, both subject (see Figure 1) and object (see Figure 2) constituents are indefinite NPs in the most cases (see variable ‘indef’). In the ‘O new’ (=object new, subject given) condition, objects are indefinite as expected, approximately 60% of subjects were encoded either through a definite NP (see variable ‘def’), or through a third person pronoun (see variable ‘3.SG’), or elided (see variable ‘e’). In contrast, the condition ‘S new’ (=object given, subject new) induces a substantial amount of definite object NPs, while subject NPs are indefinite for the most part. Finally, in the ‘V new’ (=subject and object given) condition the number of indefinite descriptions is greatly reduced both for subject and object constituents.

The distribution of referential statuses per condition suggests that speakers do assume the intended common ground manipulations for a substantial part of their performance in the experimental situation.

Figure 1: Referential status of subjects

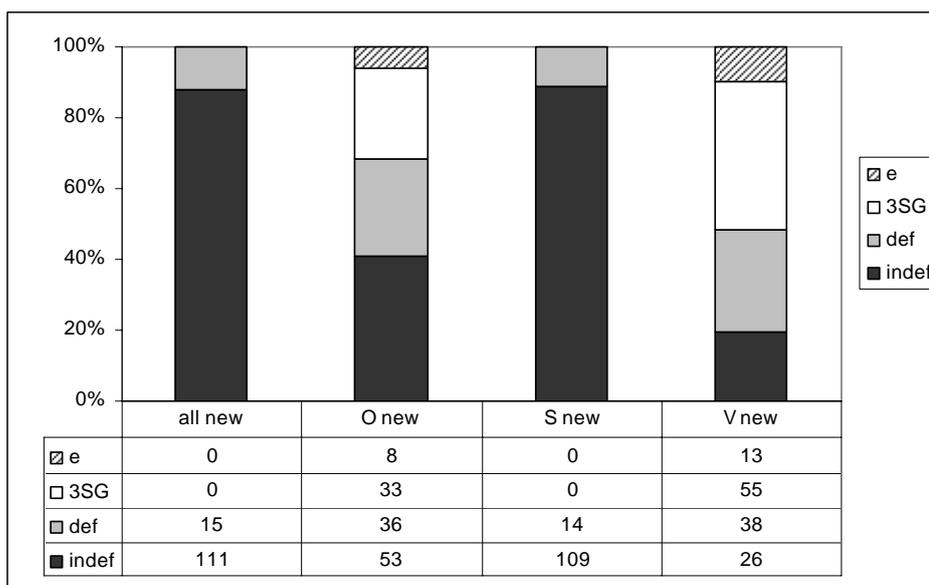
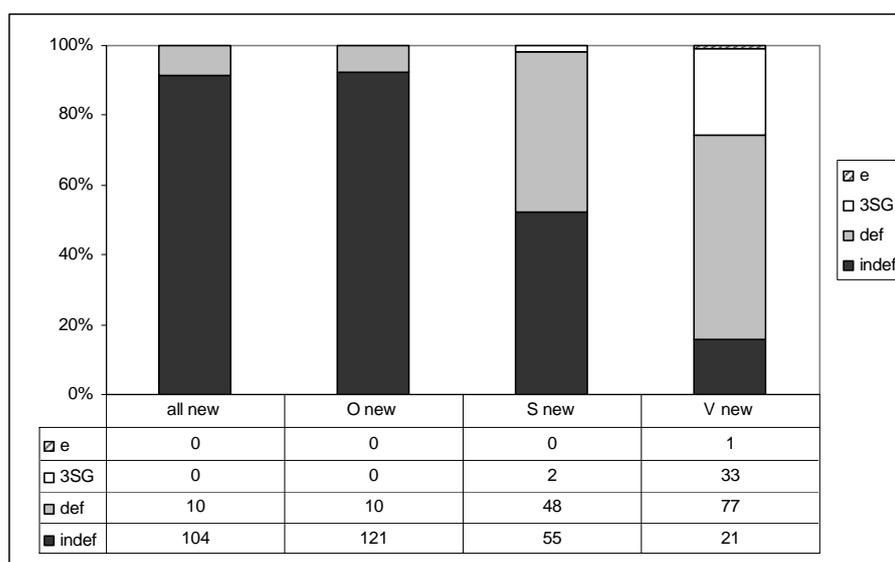


Figure 2: Referential status of objects

The question that arises is why speakers realize the intended distinctions in the referential status of NPs and not in word order. Probably the answer lies in the qualitative difference between the two phenomena. In case of the referential status, speakers have to make an *obligatory* choice between an array of structures (definite NP, indefinite NP, ‘3.SG’ pronoun, ellipsis) that do not substantially differ in terms of markedness. In case of word order, speakers have to choose among an unmarked option (i.e., the canonical word) which applies to all discourse conditions, and a marked option, namely the object-before-subject order, which is only licensed in a subset of the possible contexts. The contextual properties that would license the marked order are available, since the experiments at issue establish an asymmetry in givenness (which could induce XVOS) or contrastively topicalized objects (which could induce OVS in German). What is certainly less well recreated in the artificial communicative situation of an experimental session, is the intention of the speaker to update the assumed common ground. The fact that he chooses the unmarked structure in contexts that license a linking anaphor to the common ground suggests that he is

fulfilling the task of describing the perceived stimuli but without addressing this communication to a real addressee.

This is a possible effect of the artificial discourse setting during an experimental session. However, effects of the experimental situation should be independent of the object language, but the result obtained in German is not identical with the results obtained in other languages. Georgian speakers, for example, have used non-canonical word orders (e.g., 30% OS orders in the condition ‘subject new’ of the experiment “Visibility”, 60% in the condition ‘subject new’ of the experiment “Changes”, etc.) with identical experimental manipulations. In part, this result reveals a typological difference between German and Georgian, but it also shows that our experimental manipulation effectively elicits word order variation. Similar effects on word order have been observed in further scrambling languages like Konkani and Prinmi.

Some details of the experimental performance are special to the case of the German however. Participants in the experiments were students at the University of Potsdam who normally participate in a number of experimental sessions during their studies. Their familiarity with experimental situations may have negatively affected their intentional involvement in the simulated discourse situations. For this reason, we are looking forward to create a new dataset in German with the participation of speakers that are not used to the experimental context. Some modifications in the performance of the session are also necessary in order to create a communicative session style which was not established in the previous sessions.

3.3 Summary

In this section, we have addressed the issue of scrambling vs. topicalization and we have searched the dataset created through QUIS in order to find evidence for the assumptions in the literature concerning the information structural sensitivity

of these structures. In qualitative view, the dataset confirmed our expectations; in quantitative view, the dataset does not contain enough evidence to prove the dependence of the intended structures from particular context conditions. In comparing our results with the knowledge from natural language corpora we concluded that our dataset failed to give a representative picture of this issue in German. After further inspection of the gained data we decided to repeat a data collection with some essential modifications to the performance style, participants and some modifications of the included tasks.

4 German: Intonational patterns⁷

4.1 Hypothesis

Prosodic analysis of a subset of the data elicited in German, in selected QUIS tasks, was carried out in order to assess to what extent the findings in our data match three general claims made in the literature about the prosody of information structure in German.

A first general claim is that focus is expressed prosodically in German by means of a falling nuclear pitch accent, since focus is normally placed sentence-finally where the unmarked accent type is falling (Féry 1993, Uhmman 1991, Peters 2006). The position and type of nuclear accent observed in focus contexts was examined in relation to this generalisation. A second, related, claim is that content words which follow a narrow focus, and which are repeated from the context-setting question, are expected to be de-accented in German (Ladd 1996, Baumann 2006, Grice & Baumann 2006). The accentual properties of post-focal/given content words were examined to ascertain to what extent this

⁷ The German data was collected by Anja Arnhold and Andreas Pankau; the main prosodic analysis was undertaken by Anja Arnhold, with additional analysis by Fabian Schübo and Sam Hellmuth. We are grateful to Anja Arnhold for reviewing the theoretical background on the prosody of information structure in German.

expectation is fulfilled in our dataset. Finally, it has been noted that different accentuation patterns are observed inthetic vs. categorical sentences with an intransitive verb, with the nuclear accent on the subject inthetic sentences and on the verb in categorical sentences (Sasse 1987, Ladd 1996); thus accentuation patterns in intransitive sentences elicited in all-new context were examined.

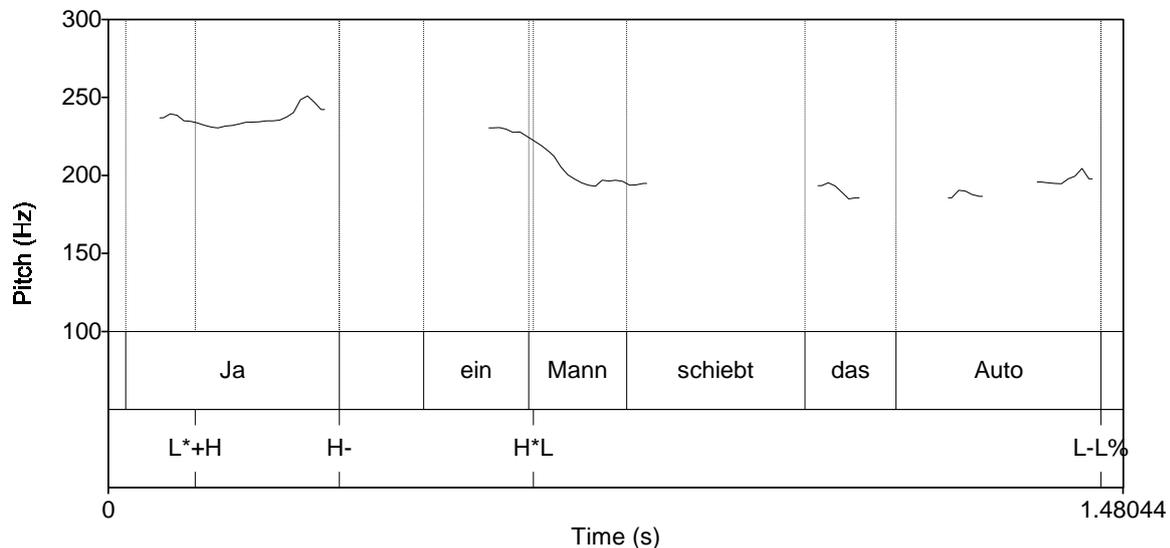
We surveyed data from 20 speakers, in two QUIS tasks: ‘Event Cards’, which elicits all-new picture descriptions in response to a broad focus question (6 stimuli x 20 speakers = 120 tokens in all; 40 tokens were disfluent leaving 80 for analysis), and ‘Anima’ which elicits focus picture descriptions in response to focus questions of various types (16 stimuli x 20 speakers = 320 tokens; 180 tokens were disfluent or elliptical, leaving 140 for analysis). All tokens included in the analysis were inspected auditorily by the first transcriber, a native speaker of German, with reference to F0 and spectrogram extracted using Praat 4.5; cases which were classified by the first transcriber as not matching the predicted hypotheses were additionally assessed independently by a further two prosodically trained transcribers.

4.2 Results

4.2.1 Nuclear/focal accents

Our survey found that 90% of wide focus sentences (72/80 tokens, in ‘Event Cards’) bore a H*L falling nuclear accent followed by low phrase- and boundary-tones, and of these, the nuclear accent was utterance-final in all but 3 tokens. In utterances containing a narrow focus (in ‘Anima’) again, in almost 90% of cases (127/140 tokens) the focus was expressed by means of a H*L falling nuclear accent followed by low phrase- and boundary-tones. An example is provided in Figure 3 below: the speaker is responding to the question ‘Who is pushing the car?’.

Figure 3: Sample falling nuclear accent (context elicits confirmation focus on ‘Mann’) (token 41-8 from speaker 14)



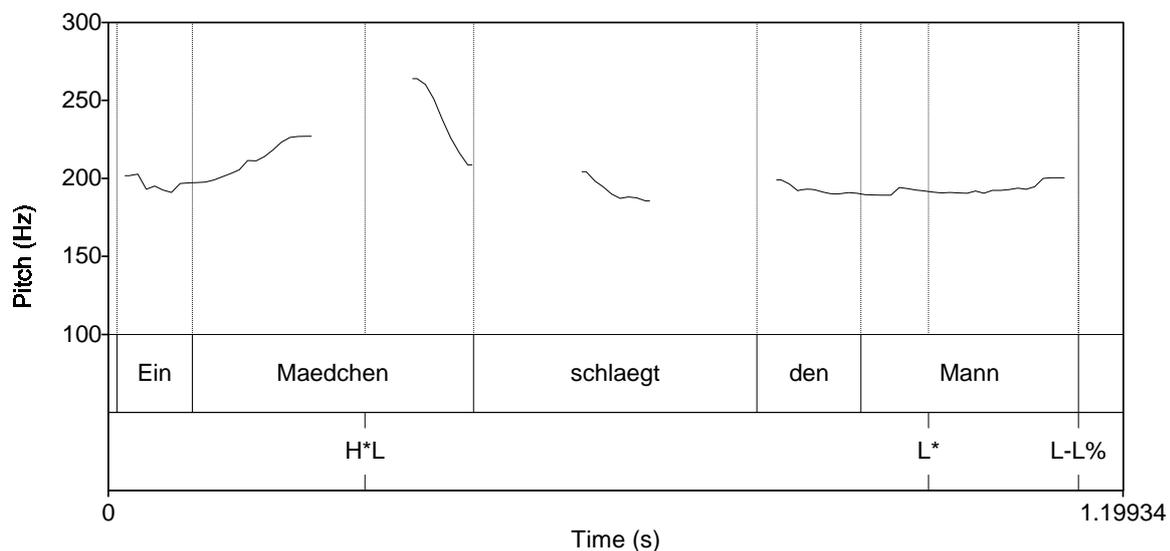
The remaining 10% of tokens (13 tokens) in the Anima task were analysed further in order to establish the patterns used: 6 tokens have a L* nuclear accent, followed by a low boundary tone; 2 have a L* nuclear accent, followed by a high boundary tone; and 5 have a rising L*H nuclear accent, followed by a low boundary tone. Overall however, the tasks ‘Event Cards’ and ‘Anima’ successfully elicited standard German prosody, with a limited degree of deviation from generalizations in the literature: the nuclear accent is in the majority of cases falling, and most exceptions to this are use of a low nuclear accent.

4.2.2 Post-nuclear de-accenting

In the ‘Anima’ task, 49 tokens contained a narrow focus in non-utterance-final position, and of these, referents following the narrow focus were de-accented in 73% of cases (36 tokens); in the remaining 27% of cases (13 tokens) referents following the narrow focus did not appear to be de-accented. Of these 13 atypical cases, 2 tokens showed a final fall-rise contour, (Féry 1993: H*+LH%; Grice et al 2005 [GToBI]: H* L-H%) and 3 contained a phrase break after the

focussed subject (thus an additional post-focal accent is expected in the new prosodic phrase). In the remaining 8 tokens the post-focal argument that was accented bore a L* accent, and was in all cases subordinate in prominence to a primary accent on the focussed referent. This is consistent with the distributional patterns described in Baumann (2006) across different speech production settings: under laboratory conditions Baumann found that a textually given item (repeated from the immediate discourse context as in our task) is invariably accented in German, whereas in a corpus study such items were also observed to bear a secondary accent (H*L accent). Although our cases are best analysed as instances of a post-focal L* (see for example in Figure 4 below), we suggest that the degree of variation in our corpus is consistent with the generalisations observed in the literature regarding German post-focal accentuation.

Figure 4: Post-focal L* accent on patient (in response to a wh-question eliciting narrow focus on the agent) (token 41-13 from speaker 4)



4.2.3 Eventives

Finally, we found an interesting result in the ‘Event Cards’ task, which was designed not only to elicit wide focus but also specifically to elicitthetic utterances, in response to an all new picture description task. In fact however,

among fluent renditions of sentences containing intransitive verbs, we found that in approximately two-thirds of the tokens the nuclear accent was on the verb rather than on the subject argument; this accentuation pattern suggests that in these two-thirds of cases speakers produced a topic-comment sentence rather than athetic sentence. An accentual ‘minimal pair’ is provided in Figures 5 and 6 below, both of which are descriptions of a picture of a sleeping baby.

Figure 5: Intransitive thetic sentence (nuclear accent on the subject)
(token 26-21 from speaker 8)

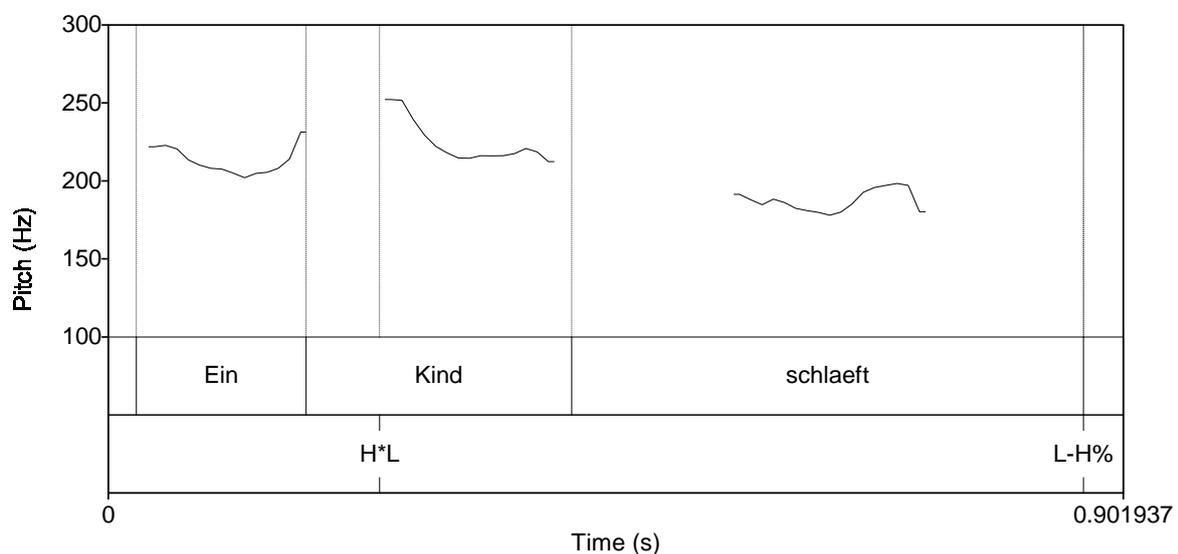
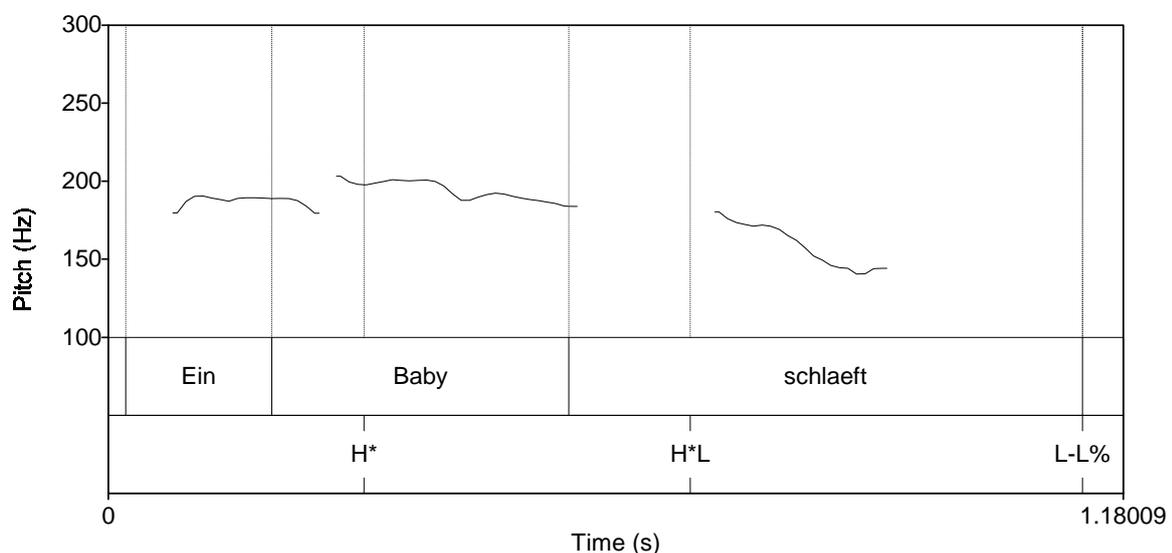


Figure 6: Intransitive categorial sentence (nuclear accent on the verb)
(token 26-21 from speaker 14)



This evidence from German prosody in ‘Event Cards’ directly parallels the situation observed in the Québec French data in the same task (see 3.3.1.3b above) and suggests that use of a picture description is not always necessarily sufficient to elicit an all-new information structure context. We are currently piloting a revised task design of Event Cards (using the same stimuli, but with a different instruction to speakers) in order to more reliably elicit thetic utterances in this task.

5 Greek: Clitic Doubling⁸

5.1 Hypotheses

The syntactic properties of pronominal clitics are probably the most intensively studied subject in Modern Greek syntax. Pronominal clitics include a paradigm of non-emphatic personal pronouns which do not bear lexical stress (in contrast to emphatic personal pronouns that bear lexical stress) and are used for accusative and genitive constituents which are part of the VP. These include direct objects, indirect objects in genitive, and genitive adjuncts which are part of the VP (e.g. beneficiaries), but not adjuncts that are outside the VP (e.g., temporal accusative/genitive adjuncts). Pronominal clitics always occur adjacent to the verb, and are part of the same phonological word as has been shown on the basis of the Stress Well Formedness Conditions of Modern Greek (Arvaniti 1992; Drachman & Malikouti-Drachman 1999; Revithiadou 1999). With the exception of imperatives and non-finite verb forms, pronominal clitics are left adjacent to the verb in the standard variety of Modern Greek.

⁸ The Greek data was collected, transcribed and evaluated by Thanasis Georgakopoulos (Univ. of Athens), Yannis Kostopoulos (Univ. of Athens), and George Markopoulos (Univ. of Athens) in conjunction with project D2.

Two syntactic constructions with pronominal clitics are of particular relevance for the study of information structure: *clitic left dislocation* (hereafter, CLLD) und *clitic doubling* (hereafter, CL). Both constructions contain a NP which is co-referent to the clitic: in CLLD, the doubled NP is left dislocated (see (16a)), while in CL the doubled NP is placed to the right of the verb (see (16b); see further Anagnostopoulou 1994, 1999; Alexiadou 1999; Revithiadou & Spiropoulos 2004). In some accounts the doubled NP in CL is treated as right dislocated, in parallel with CLLD (see Philippaki-Warburton 1994, 1998, Androulakis 2001), but many authors have challenged this view pointing out that, amongst a number of arguments: (a) there are crucial differences in the contexts that license the two constructions and (b) the doubled constituent in CL may precede the focussed constituent, which poses a syntactic problem if the doubled constituent is analyzed as right dislocated (see Anagnostopoulou 1994, Iatridou 1995, Alexiadou 1999).

- (16) (a) to vivlío to Diávasa.
 DEF:ACC.SG.N book:ACC.SG.N 3.SG.ACC.N read:AOR:1.SG
- (b) to Diávasa to vivlío.
 3.SG.ACC.N read:AOR:1.SG DEF:ACC.SG.N book:ACC.SG.N

CLLD and CL are not licensed in identical contexts. CL requires a referent which is prominent enough in the common ground to be uniquely identified (see Anagnostopoulou 1994). Arguments in CL represent given information which is part of the information structural background (Alexopoulou & Kolliakou 2001, Vallioli 1993). These requirements of givenness and out-of-focus status are necessary conditions for CL itself, but the use of a *non-clitic doubled* postverbal constituent is always possible.

Most studies on the contextual licensing of clitic constructions are devoted to CLLD. This construction is less restrictive with respect to the discourse status and applies also with new referents that are discourse linked (Anagnostopoulou

1994). In contrast to CL, CLLD requires a pragmatic condition of some kind, to trigger left dislocation, frequently contrastive topicalization (see Iatridou 1995). Alexopoulou (1999) and Alexopoulou & Kolliakou (2001) present an attempt to identify the context conditions that license CLLD: their approach is based on the notion of ‘linkhood’ as defined in Vallduví (1992) and refined by Hendriks & Dekker (1996) in the ‘non-monotone anaphora hypothesis’. In this framework, CLLD is induced when the referent of the doubled constituent X is an anaphor to an antecedent discourse referent Y, such that Y is not a subset or equal to X. That is, either the referent of the doubled constituent is a subset of its antecedent or the two sets do not intersect.

There are only a few quantitative empirical studies on Greek clitic doubling. Roland (1994) presents a corpus study about the occurrence of clitic doubling measuring the anaphoric and cataphoric occurrence of the referent of the clitic doubled NP which is in line with the above generalizations. Keller & Alexopoulou (2001) measure the influence of word order, sentence accent and clitic doubling on the acceptability of sentences in several contexts through magnitude estimation. Their results confirm the proposal of a (violable) constraint on doubling preverbal objects as well as a constraint on interpreting doubled objects as ground (in Vallduví’s 1992 terms).

In the following section, we will explore the data obtained through QUIS in order to test two hypotheses concerning CLLD which have attracted particular attention in the literature:

(17) Hypotheses

- (a) CLLD is induced when a doubled constituent is a contrastive topic.
- (b) CLLD is induced when a doubled constituent is an anaphor to an antecedent referent, such that it is either a subset of it or does not intersect with it.

5.2 Results

5.2.1 Contrastive topicalization

Hypothesis (a) predicts that discourse conditions that trigger contrastive topicalization will induce clitic doubling in Greek. This hypothesis may be tested in the data obtained through the experiment “Who does what?”. In this experiment, the speaker is shown a picture which presents two parallel (identical) events in which two pairs of different individuals are involved. Then he is asked a question and answers it in a “natural” way. Several question types are used in the different experimental conditions. The question relevant here is the multiple subject question, e.g. “Who is pushing the chair and who is pushing the table?”. According to hypothesis (a), this question will induce contrastively topicalized object constituents (see Skopeteas & Féry, i. pr.).

In a total of 16 tokens obtained in this experiment, 2 displayed verb ellipsis in both conjuncts, and thus no clitic doubling is possible:

(18) Context:

‘Who is biting the boy and who is biting the girl?’

Answer (Greek):

o skílos to aGóri
 DEF:NOM.SG.M dog:NOM.SG.M DEF:ACC.SG.N boy:ACC.SG.N
 ce i Gáta to korítsi.
 and DEF:NOM.SG.F cat:NOM.SG.F DEF:ACC.SG.N girl:NOM.SG.M

‘The dog the boy, and the cat the girl.’

In 5 tokens the target construction was obtained as illustrated in (19). The object constituents in this answer are contrastive topics, indicated by CLLD.

(19) Context:

‘Who is eating the apple and who is eating the banana?’

Answer (Greek):

to mílo to trói i
 DEF:ACC.SG.N apple:ACC.SG.N 3.SG.ACC.N eat:3.SG DEF:NOM.SG.F
 jinéka ce ti banána ti
 woman:NOM.SG.F and DEF:ACC.SG.F banana:ACC.SG.F 3.SG.ACC.F
 drói o ánDras.
 eat:3.SG DEF:NOM.SG.M man:NOM.SG.M

‘The woman eats the apple, and the man eats the banana.’

Alternatively, speakers have given answers in the canonical order as illustrated in (20). Notice that in the case of postverbal object constituents the requirements for CL are not fulfilled: since there is a set of two individuals that are involved as patients in the corresponding events, the referent of the object constituent is not uniquely identifiable, which renders clitic doubling unacceptable. None of the sentences with canonical order exhibit clitic doubling.

(20) Context:

‘Who is eating the apple and who is eating the banana?’

Answer:

i jinéka trói to
 DEF:ACC.SG.F woman:NOM.SG.F eat:3.SG DEF:NOM.SG.N
 mílo ce énas ánDras
 apple:ACC.SG.N and INDEF:NOM.SG.M man:NOM.SG.M
 trói ti banána.
 eat:3.SG DEF:ACC.SG.F banana:ACC.SG.F

‘The woman eats the apple, and a man the banana.’

The results obtained are summarized in Table 2. Overall 12.5% of the dataset is not relevant for the hypothesis at issue. In the remaining data, the experiment provides evidence that Greek speakers use the CLLD construction in 35.7% of cases involving contrastive topicalization of object constituents.

DEF:ACC.SG.N goal:DIM:ACC.SG.N 3.SG.ACC.N=eat:3.SG

o típos.

DEF:NOM.SG.M guy:NOM.SG.M

‘The little goal, the guy has eaten it.’

Though single examples of CLLD are obtained in the context condition illustrated in (21), the overall result shows that the licensing context as identified by Alexopoulou & Kolliakou (2001) is not a *sufficient* condition for CLLD.

The next question to ask is whether the assumed licensing context is a *necessary* condition for CLLD. We can check this hypothesis by observing data obtained by means of the experiment “Visibility”. This experiment is also based on descriptions of picture sequences: in the condition which is relevant for our purposes, the target picture contains a patient which has already been presented in the previous picture. In the account of Alexopoulou & Kolliakou (2001), this context will not license CLLD, since the target referent is equal to the antecedent.

The data obtained in this experimental condition (63 descriptions in total) illustrate different types of possible structures with given patients in Modern Greek. 6 descriptions had to be excluded because they failed to instantiate the intended context condition.

16 further descriptions have to be ignored because they contain a sentence that introduces the new referent before the expression of the target event. In the descriptions that consist in a simple sentence, the given patient is often expressed through the clitic pronoun (12 sentences) and do not have a reference to the given referent through a lexical NP. These types of sentences are completely predictable for the contextual condition at issue, but do not contribute to the question whether a lexical NP is anteposed and clitic doubled when it refers to a given referent. The relevant subset contains the simple sentences in which the speaker decides to encode both referents in lexical NPs

and this subset is the 46% of the obtained data. Since the patient is given, this context may induce two sentence types in Modern Greek: Canonical sentences with deaccented object constituents and CL. These sentence types are very well represented in the dataset (see Table 3).

The crucial point for our discussion on CLLD is that this construction has been also induced in the context of given patients, as illustrated in example (22). This pattern was encountered in 10.3% of simple sentences with two lexical NPs (3/29 sentences).

(22) [picture 1 is presented]

éna	aGóri	stécete...
INDEF:NOM.SG.N	boy:NOM.SG.N	stand:3.SG

‘A boy is standing...’

[picture 2 is presented]

ce	tóra	aftó	to	aGóri	to
and	now	this:ACC.SG.N	DEF:ACC.SG.N	boy:ACC.SG.N	3.SG.ACC.N

éCi	pári	s=tin	agaLá	tu
have:3.SG	take:N.FIN	LOC=DEF:ACC.SG.F	lap:ACC.SG.F	3.SG.GEN

énas	ánDras
INDEF:NOM.SG.M	man:NOM.SG.M

‘...and now this boy, a man has taken it onto his lap.’

Table 3: Greek data obtained in ‘given patient’ descriptions

total		63	
	other		6/63
	complex description		16/57
	ScIV		12/41
	CLLD		3/29 (10.3%)
	✓CL		1/29 (3.4%)
	✓canonical sentences		25/29 (86.2%)

Examples like (22) suggest that the non-monotone anaphora hypothesis is not a necessary condition for Greek CLLD. However, notice that the experimental procedure does not induce a continuous narrative, since the description is interrupted through the presentation of the second picture. This interruption has the effect that the speaker often resets the discourse referents when producing the target description and accounts for the fact that the 46% of the sentences contain two lexical NPs. The fact that this aspect of the discourse flow induces CLLD suggests that the necessary condition for CLLD may not be able to be captured strictly in terms of the semantic relation between the target referent and its antecedent, but should include any contextual conditions which may motivate the speaker to render a salient state to the anaphor.

Furthermore, this result is in line with the empirical data gained through an experiment on gradient acceptability in Keller & Alexopoulou (2000). The experimental data provided evidence for a constraint *DOUBLEGROUND* (= “doubled objects have to be interpreted as ground”, whereby ground is the non-focussed partition of the sentence in terms of Vallduví 1992). Both orders *ScIVO* and *OclVS* have been judged as highly acceptable (without significant difference between them) in the context of subject focus questions, though the doubled object constituent was part of the question background, which is not the context that licenses *OclVS* (i.e., CLLD) according to the hypothesis at issue.

5.3 Summary

Based on data collected through several experiments of QUIS, we have tested two basic accounts about the function of CLLD in Greek. First, we examined the hypothesis that contrastive topicalization of object constituents induces CLLD and we identified an experimental condition which outputs substantial quantitative evidence in support of this claim. Second, we examined the hypothesis that CLLD is induced when the object constituent is a linking anaphor to the common ground and we found single examples that illustrate this claim. Furthermore, we found counterexamples to this hypothesis which suggest that the hypothesis at issue does not display a necessary condition for the production of CLLD, and our finding is in accordance with other empirical data reported in recent literature.

Putting the results together, they rather suggest that the exact information structural function of CLLD or the semantic relation of the doubled constituent to the antecedent is underspecified. Anteposing a given constituent renders a salient status to it, which may be motivated by several contextual conditions: by contrastive topicalization (see 5.2.1), by a link-like anaphor (see (21)), or by properties of the discourse flow such as the reestablishment of the common ground in example (22).

6 Hungarian: Focus position⁹

6.1 Hypothesis

Hungarian is a discourse configurational language with two preverbal positions for topic and focus respectively. In syntactic analysis of Hungarian focus constructions, focused constituents are placed in the Specifier position of a

⁹ The Hungarian data has been collected, transcribed and evaluated by Krisztian Tronka in cooperation with D2.

functional projection for focus (FP) (see Bródy 1990; Kiss 1992, 1998). Focus triggers movement of V-to-F which guarantees adjacency of the focused constituent to the verb. Evidence for this movement is found in the behaviour of verbal prefixes, which constitute a phrasal category in Hungarian (Spec,PredP in Kiss 2006 or PredOP in Farkas & Swart 2003) that in canonical sentences precedes the verb. When a constituent occupies the focus position, the verbal particles have to occur postverbally (Kiss 1998, 2006).

Following Kiss (1998), the Specifier of the focus position bears the feature of identificational focus, which is defined as a “subset of the set of contextually and situationally given elements for which the predicate phrase can potentially hold”, and namely “the exhaustive subset of this set for which the predicate phrase actually holds” (Kiss 1998:245). While the preverbal position is reserved for exhaustive identification, postverbal constituents may bear new information focus. It is crucial that identificational focus is a feature associated with the preverbal position and only with it, which implies that it is the necessary and sufficient condition for focus movement.

Szendrői (2001, 2003) adopts a radically different viewpoint on the motivation of focus movement in Hungarian. Following the Hungarian stress rule, the most prominent stress of the clause falls on the leftmost part of an IntP. Since topicalized constituents form individual IntPs, the leftmost part of the canonical Hungarian clause is the verb. If a constituent moves to the focus position, then it is this constituent that bears the most prominent stress in the clause. Postulating a Stress-Focus Correspondence principle (following Reinhart 1995), Szendrői concludes that focus movement to the left periphery is triggered by this rule, i.e. a focussed constituent moves to the preverbal position in order to receive stress. In contrast to moved constituents, postverbal constituents receive phrasal stress while main stress of the VP falls on the verb. They do not bear a [+new information focus] feature, but they may be part of a widely

focussed VP. Szendrői (2001, 2003) does not deny that preverbal NPs have an exhaustive interpretation, while postverbal NPs are interpreted non-exhaustively, which she attributes to the presence or absence of movement. The main point of her account is that focussed constituents move to the left periphery in order to get stressed and not in order to be checked for [+ identificational focus].

The idea of movement driven by an identificational focus feature is furthermore challenged by Wedgwood (2003, 2007) in view of the semantic properties of this construction. Wedgwood argues that the exhaustive interpretation is not obligatory associated with the Hungarian preverbal position. The fact that many expressions in this position trigger an exhaustive interpretation results from inferences which are based on the incremental interpretation of the encoded meaning.

Summarizing the above accounts, the exhaustive identification of a constituent will induce movement to the preverbal position. Following Kiss (1998), the focused constituent moves to this position in order to be checked by the exhaustive operator and following Szendrői (2001, 2003) in order to get the prominent stress of the clause. This hypothesis does not contradict the account of Wedgwood (2003, 2007), since this account shows that exhaustivity is not a *necessary condition* for movement to the focus position.

(23) Hypothesis I:

Contexts that motivate exhaustive identification will induce movement to the focus position.

The presented accounts make different predictions in the case that the context does not induce an exhaustive identification of the referent. The critical condition is the case that only one constituent is focused (and no exhaustivity applies). The feature-driven account predicts that the constituent will be placed postverbally in this case (since it does not need to get checked by the

identificational operator), but the stress-driven account predicts that the constituent will be placed preverbally (in order to get in the prominently stressed position of the clause). The latter account is also in accordance with the view of Wedgwood (2003, 2007) that states that also prosodic motivation may trigger movement to the preverbal position.

(24) Hypothesis IIa (feature-driven):

Contexts that motivate focus on a single constituent without involving exhaustive identification will not induce movement to the focus position.

(25) Hypothesis IIb (stress-driven):

Contexts that motivate focus on a single constituent without involving exhaustive identification will induce movement to the focus position.

6.2 Results

Hypothesis I may be tested in the question-answer experiment “Anima”. In this experiment, the informant is shown four pictures. After 1 min., the pictures are taken away and the informant is asked four questions which belong to different question types, that all motivate an exhaustive answer. Subject questions were always answered with a sentence, in which the subject is in the focus position, and the object in situ (see Table 4).

(26) Question: Who is looking at the girl?

a férfi néz a la:JrO
 DEF man look:3.SG.PRS DEF girl-SUB
 ‘The man is looking at the girl.’

Object questions induced movement of the object to the focus position. This was manifested in several sentence types differing in the status of the subject (topicalized, postverbal or elided, see Table 5).

(27) Question: Whom was the man pulling?

Egy nőt rángatott a férfi.

INDEF woman pull-3.SG.PST DEF man

‘The man was pulling a woman.’

Table 4: Hungarian data obtained in subject questions

total	16
other	1
✓ S _F VO	15 (100%)

Table 5: Hungarian data obtained in object questions

total	16
✓ O _F VS	3 (18.7%)
✓ SO _F V	12 (75%)
✓ O _F V	1 (6.2%)

Table 4 and Table 5 make clear that Hypothesis I has been fully confirmed by the data collected through QUIS.

Hypothesis II addresses the question whether movement in focus position is possible without the prerequisite of exhaustive identification when a single constituent is focused. The context condition at issue is a case of conflict for the accounts presented in 6.1, since the feature driven account does not predict focus movement in this case while the stress driven account does. QUIS provides an experiment that establishes the appropriate discourse condition (experiment “Changes”). The experimental procedure is description of picture sequences. The pictures that are described after one another differ in only one feature: either the agent, or the patient or the event changes. This experimental manipulation induced descriptions like those presented in (28).¹⁰ In the second description, the verb is D-linked, since it is identical to the verb of the previous sentence. The

¹⁰ The available data is very few for a quantitative account.

new feature of the scene is the object constituent (*ládát* ‘box-ACC’), which moves to the preverbal position.

(28) [first picture]

Egy férfi tol egy autót
 INDEF man push:3.SG.PRS INDEF car-ACC
 ‘A man is pushing a car...’

[second picture]

a férfi egy ládát tol
 INDEF man INDEF box-ACC push:3.SG.PRS
 ‘...the man is pushing a box.’

In each scene, there is only one patient for which the predicate holds, which could allow for an expression of exhaustivity. However, the description of a sequence of scenes with new patients does not meet an important condition of exhaustive identification (see definition in section 6.1): the patient is simply a new referent and not a member of a contextually or situationally given set of referents for which the predicate potentially holds. For this reason, this experimental setting did never elicited expressions containing an explicit mention of exhaustivity, e.g., “now the man is pushing only a box”. An explicit mention of this kind would be true with respect to the perceived stimulus, but it would be completely unmotivated in this context because it evokes the assumption of a presupposition that the man was pushing more than one thing in the scene under description. If this understanding of the context conditions is on the right track, this example supports the stress-driven account for Hungarian focus movement.

6.3 Summary

We have shown that there are different claims about the functional motivation of the movement to preverbal position in Hungarian. All accounts presented

however agree that exhaustive identification of a referent will induce movement to this position. According to the feature-driven account exhaustive identification would be the motivation for movement; according to the stress-based account exhaustive identification would be an epiphenomenon. Our data has verified the assumption that this context induces focus movement in Hungarian. Already in the small dataset obtained through the QUIS the trend of the data in exhaustivity inducing questions is completely clear.

Furthermore, we have seen that the presented accounts have different implications for contexts that induce new information focus on a single constituent. In this context, only the stress-driven account predicts movement to the preverbal position. Our production data confirms the hypothesis of this account. Supposing that the material discussed in section 6.2 is not eliciting exhaustively identified objects, we have shown by means of single examples from our dataset that exhaustivity is not a necessary condition for Hungarian focus movement.

7 Conclusions

This paper illustrates some of the issues involved in interpreting speech production data elicited by means of visual stimuli, but also demonstrates the effectiveness of this paradigm for testing hypotheses in the theoretical literature on information structure.

In all of the case studies presented above, it was necessary as a first step to identify which tokens in the dataset represent an attempt to render the intended information structure context. Tokens in which the speaker speaks about the picture itself ('I see a man pushing a car') indicates that the informant is assuming a different common ground between speaker and hearer than was intended in the design of the experiment. We suggest that cases such as these do

not represent a failure of the experimental paradigm, but rather an inevitable outcome of the choice to elicit information structure by means of visual stimuli. Since our experiments elicit a good proportion of tokens in which the informants do render the information structure context as intended, the decision to adopt visual stimuli is supported, and will be further vindicated in future as the number of languages grows for which parallel data elicited with QUIS are available.

Within the subset of data in which the intended information structure context appears to have been elicited, we are able to compare the results with the predictions and generalizations in the literature. In the case studies set out above we see alternative outcomes from this comparison: in some cases our data mostly or fully match the expected results, validating the experimental paradigm implemented in QUIS; in other cases our data fail to match the expected results, but tend to do so in ways that are revealing, thus enabling us to develop more refined research questions for specific languages as well as more finely tuned experimental methodology.

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