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Multiple Focus

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▶ Abstract

This paper presents the results of an experimental study on multiple focus configurations, that is, structures containing two nested focus-sensitive operators plus two foci supposed to associate with those operators. There has been controversial discussion in the semantic literature regarding whether or not an interpretation is acceptable that corresponds to this association. While the data are unclear, the issue is of considerable theoretical significance, as it distinguishes between

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the available theories of focus interpretation. Some theories (e.g. Rooth's 1992) predict such a pattern of association with focus to be impossible, while others (such as Wold's 1996) predict it to be acceptable. The results of our study show the data to be unacceptable rather than acceptable, favouring important aspects of the theory of focus interpretation developed by Rooth.

▶ 1. INTRODUCTION

The semantic literature on focus debates the question of whether association with focus can skip an intervening focus-sensitive operator or not, and if it can, under what circumstances this is possible. An example that illustrates the point is given in (1) (from Rooth 1996a^[4]).

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- (1) We only introduced [Marilyn]_F to John Kennedy.
 We also only introduced [Marilyn]_F to [Bob Kennedy]_F.
 'Another person who we introduced only Marilyn to is Bob Kennedy.'

The second sentence in (1) on the intended interpretation instantiates the situation in (2). A focus-sensitive operator Op1 should associate with a focus F1 that is c-commanded by a closer focus-sensitive operator Op2 (which comes with its own focus F2). The question we address in this paper is whether an interpretation reflecting this pattern of association exists.

- (2) Op1 ... [Op2 [X ... F2 ... F1 ...]]

Conflicting views on this are reported in the literature. This is not surprising since the empirical facts which lie at the heart of the debate are subtle and have so far been evaluated largely by the traditional introspective method alone. It is well known (Schuetze 1996^[4]) that the subjective intuition of a researcher is, in difficult cases such as these, not the best way to answer an empirical question; what is needed is an objective experimental evaluation. This paper presents the results of an experimental study using stimuli representing the configuration in (2). The study shows that such configurations are very problematic; hence, a theory of association with focus ought to assume that (2) is not possible.

We present the relevant background on association with focus in Section 2. Section 3 reports the experiment and Section 4 summarizes our conclusions.

▶ 2. THEORETICAL BACKGROUND

2.1. The interpretation of focus

Focus introduces alternatives.¹ In (3), focus on the verb invokes alternative relations between Renate and ‘Pride and Prejudice’—for example ‘read’.

(3) Renate WATCHED ‘Pride and Prejudice’.

Those alternatives are inherited in the larger structures containing the focused item. The VP in (3) makes available alternatives like the ones in (4a), and the whole sentence, accordingly, the ones in (4b) (what alternatives precisely are invoked depends on the context; this does not concern us here).

- (4) a. $\{\lambda x.\lambda w. x \text{ watched P\&P in } w, \lambda x.\lambda w. x \text{ read P\&P in } w\}$
 = {reading P&P, watching P&P}
 b. $\{\lambda w. \text{Renate watched P\&P in } w, \lambda w. \text{Renate read P\&P in } w\}$
 = {that Renate watched P&P, that Renate read P&P}

Alternatives become relevant to semantics or pragmatics at certain points. This can be when we evaluate contrast, as in (5), or when we decide what ‘only’ quantifies over in (6).

- (5) A: Renate read ‘Pride and Prejudice’.
 B: No—Renate WATCHED ‘Pride and Prejudice’.

(6) Renate only WATCHED ‘Pride and Prejudice’.

(5B) is an appropriate response to (5A) because the proposition expressed by (5A) is one of the alternatives that (5B) invokes. We evaluate those alternatives, that is, make use of them, when we establish the contrast relationship in (5). The alternatives become relevant (are evaluated) at sentence level. Example (6) says that there is no relevant relation between Renate and ‘Pride and Prejudice’ other than watching. This comes about through the contribution of VP-adjoined *only* in (7) by identifying the set of relevant properties C as the focus alternatives of the sister of *only* (i.e. the context would determine a variable assignment function g such that $g(C) = (4a)$). This results in (6') as the meaning of (6), the intuitive interpretation (compare Rooth 1985², 1992³).

- (7) $[\text{only}_C]^g = \lambda Q.\lambda x.\lambda w. \forall P[g(C)(P) \ \& \ P(x)(w) \ \rightarrow \ P = Q]$
 (6') $\lambda w. \forall P[P \in \{\text{reading P\&P, watching P\&P}\} \ \& \ P(\text{Renate})(w) \ \rightarrow \ P = \text{watching P\&P}]$
 ‘the only property out of {reading P&P, watching P&P} that Renate has is reading P&P’

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Operators that make use of focus alternatives in their semantics are called focus-sensitive operators. That could be focus-sensitive adverbs like *only*, *also* and *even* and discourse-level operators (compare e.g. Krifka 1995); or we could endorse a more abstract theory like Rooth's (1992), according to which a single operator (the \sim operator) always handles the interface between focus and focus-sensitive operators such as *only*.

But this is not the issue we want to discuss. The question raised in this paper concerns a particular aspect of the mechanism of focus evaluation.² Suppose that we have such an operator that evaluates focus alternatives, and suppose that there is more than one focus in its scope. Does the operator necessarily evaluate all foci? Or can it use one and ignore the others? Are the alternatives introduced by these foci passed on for the calculation of alternative sets above the focus-sensitive operator? Or would the alternative set for the whole sentence in (6), for example, be the set in (8) in which the focus on *watch* is used up and no longer affects the construction of alternative sets above *only*?

(8) {that Renate only watched 'Pride and Prejudice'}

We will consider two possible theories of focus evaluation:

- (A) Focus evaluation affects all foci in the scope of the evaluating operator.
Alternatives triggered by these foci are not passed on for the construction of alternative sets higher in the structure.
- (B) Focus evaluation is selective: it can use (and use up) one focus and pass on the others.

(A) is implemented in Rooth's (1992) theory, and (B) in Wold (1996) [for the detailed semantic analyses from which (A) and (B) follow, see these papers]. Let us reconsider the situation in (2) (repeated from above), and the predictions that (A) and (B) make about sentences in which more than one focus and more than one evaluating operator occur and stand in the structural configuration indicated:

(2) Op1 ... [Op2 [X ... F2 ... F1 ...]]

Theory (A) predicts that the alternatives introduced by F1 cannot be used by Op1 because they are already used by Op2 and then forgotten for the purposes of the alternative sets for the larger structures. Association with focus should never be possible across an intervening operator. Theory (B) predicts that association of Op1 with F1 is fine. The next subsection examines the literature on this subject and illustrates the theoretical question raised here with some examples.

2.2. The literature on multiple focus

It is claimed in the literature (e.g. Krifka 1991; Rooth 1996a) that a focus can skip one focus-sensitive

operator and associate with a higher one. Example (9) is from Krifka (1991) [1], and we repeat Rooth's (1996a) example (10b) (= (1) above), which is claimed to allow the interpretation described in the paraphrase.³

- (9) John also only drank WATER.
- (10) a. We only introduced [Marilyn]_F to John Kennedy.
 b. We also only introduced [Marilyn]_F to [Bob Kennedy]_F.
 'Another person who we introduced only Marilyn to is Bob Kennedy.'

We know that the focus on 'Bob Kennedy' skips a focus-sensitive operator because *only* obligatorily associates with focus (here: 'Marilyn'), but 'Bob Kennedy' associates with the structurally higher *also* in the interpretation paraphrased. The structure according to Rooth's (1992) theory would amount to (10'), with the association indicated. This is an instance of (2), notice, since there is a constituent containing both foci which is c-commanded by Op2 (*only*), and Op1 (*also*) in turn c-commands Op2.

- (10') [also_C [only_D [x we introduced Marilyn_{F2} to [Bob Kennedy]_{F1}]]]]

The theory of Rooth (1992) [2] [amounting basically to theory (A)] predicts the association of *also* and 'Bob Kennedy' to be impossible, contrary to the intuition reported in Rooth (1996a) [3]. Rooth (1996a) [3] considers the alternative LF in (10'') for the example. Here, 'Bob Kennedy' has moved out of the c-command domain of *only* at LF and is now free to associate with *also*. The structure (10'') no longer instantiates (2). Since we know independently that phrases can move at LF, nothing precludes (10'') as a possible LF of (10b), and we do after all derive the relevant reading (so Rooth argues).

- (10'') [also_C [[Bob Kennedy]_{F1} [3 [only_D [I introduced Marilyn_{F2} to t3]]]]]]

This makes the prediction that skipping an intervening focus-sensitive operator should be possible only when movement can come to the rescue. Rooth tests this prediction with (11), where the focus is embedded inside a relative clause (an island for movement).

- (11) a. We only recovered the diary entries that MARILYN made about John.
 b. We also only recovered [the diary entries [that Marilyn made about BOBBY]]
 'Another person such that we recovered only Marilyn's diary entries about him is Bobby.'

Rooth reports that association with *also* is still possible, and leaves the example as a problem for a restrictive theory of movement. Krifka (2006) points out that this example does not establish unambiguously that ‘Bobby’ is inside the island, observing that ‘about Bobby’ would be interpretable outside the relative clause. He argues on the basis of further data that island effects do show up in that, when both foci are clearly inside the island, association with two different operators is bad.

Wold (1996), on the other hand, is led by the kinds of data discussed here to the suggestion that focus evaluation is not, after all, unselective in that it affects all foci in its scope. He develops a version of the theory in which the evaluating operator itself bears an index, and evaluates only the contribution of coindexed foci. A representation of (10b) would then look as in (12).

(12) [also₁ C [only₂ D [I introduced Marilyn_{F2} to [Bob Kennedy]_{F1}]]]]

See Wold (1996) for semantic details. Suffice it to say that the indexed operator only uses those foci that bear the same index. This predicts that association of focus across intervening focus-sensitive operators is completely free. We have called this theory (B) above.

However, von Stechow (1994: 49, Fn 44) observes that when the order of *only* and *also* is reversed, the relevant reading is completely impossible. His example is (13;B2). This is not what we expect under either Rooth's movement theory or Wold's theory.

- (13) A: I know that John drank water at the party. What else did he drink?
 B1: Besides water he only drank [CARrot juice]_F.
 B2: #He only also drank [CARrot juice]_F.

Beck (2006) also claims that multiple focus is not as freely possible as theory (B) would have it. She tests association of a focus-sensitive operator across ‘only’ and negation in English (with seven speakers) and German (with ten speakers) in an informal survey. One of her English examples is given below. According to her results, many speakers reject such association, though four out of seven English speakers accepted association across ‘only’ in (14) as indicated by the interpretation given below (14B), fixed by the context. Beck (2006) did not find any island effects.

- (14) A: You only told THE BOSS that Maria met Sally
 B: Right. I also only told the boss that Maria met BILL.
 %Another person such that I told only the boss that Maria met him is Bill.

There is thus no agreement on the data, which obviously are fairly subtle. At the same time, the issue is important for our view of how the evaluation of focus in natural language proceeds. Competing theories of focus interpretation are on the market (e.g. Rooth 1992, 1996a; Wold 1996; Geurts & van der Sandt

2004; Sauerland 2005, Krifka 2006), and this empirical domain potentially differentiates between them (compare for recent discussion e.g. Büring 2006; Rooth 2006). It is the purpose of the study reported in the next section to gather reliable empirical evidence that will help us to decide between the different theories.

It should be stressed that while there has recently been a fair amount of research done on sentences containing more than one focus (see e.g. Büring 2006; Féry & Ishihara 2005; Rooth 2006; Beaver *et al.* 2007), the multiple-focus configuration (2) has not been systematically tested empirically. This distinguishes the present investigation from others. In many examples in the recent literature, the primary focus occurs outside the domain of the second occurrence focus (SOF) evaluating operator [data discussed in Féry & Ishihara 2005; Büring 2006; Rooth 2006; (15) is taken from Rooth's paper]. Such data are fine; for instance, the structure of (15b) does not instantiate (2).

- (15) a. Eva only gave xerox copies to the GRADUATE students.
No, PETR only gave xerox copies to the graduate SOF students.
- b. Mary only STEAMS vegetables, and even JOHN only steams SOF vegetables.
[even_C [John_{F1} [only_D [steams_{F2} vegetables]]]]
- (2) Op1 ... [Op2 [x ... F2 ... F1 ...]]

We now turn to the experiment that will help us decide upon the acceptability of structures instantiating (2).

▶ 3. THE EXPERIMENT

3.1 Method

3.1.1 Participants

Sixteen native English speakers were recruited from Berlin and surrounding areas for this study, and they were paid twenty Euros for completing the experiment; the experiment was conducted in Berlin (in a laboratory provided by the Zentrum für Allgemeine Sprachwissenschaft) and Potsdam (Vasishth Language Processing Lab, Institute for Linguistics). Both laboratories were sound-proof.

The mean age of participants was 28.87 years, SE = 1.85 (median 28, minimum 20, maximum 46, first quartile 23, third quartile 34); eight were females and seven males; 12 were from the USA and the remainder were from the UK. The median number of non-native languages spoken by them was 1. The distribution of foreign languages was French: five speakers; Spanish: four speakers; German: 10 speakers; Japanese: one speaker; Italian: one speaker. Of the 16 participants, three failed to complete the full experiment; they

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completed only the first session of the experiment (described below).

3.1.2 Procedure and stimuli

The software Linger (<http://tedlab.mit.edu/~dr/Linger/>) was used for presenting items to participants. At the start of the experiment, participants were seated in front of a computer (~45 cm from the screen) and presented with instructions on the computer screen (the instructions are provided in the [Appendix A](#)). Then they were shown a discourse context on the screen; the context was also made available to them in printed form on a piece of paper. Participants were instructed that the sentences they would hear during the experiment would refer to the situation described in this text. Participants were allowed to look at the text as long as necessary in order to internalize the context, and during the experiment (but before they started a trial), they were also allowed to look at the context again if they needed to refresh their memory. There was only one context situation for the experiment.

When the participant decided that he/she had comprehended the context and was ready to carry out the task, he/she pressed the space bar of the computer keyboard and heard a dialogue through headphones. The dialogue consisted of a pair of sentences that was either a target, a control (these are described below) or a distractor. After hearing the dialogue, the computer screen prompted the participant for an acceptability judgment rating; a rating of 1 indicated that the sentence was completely unacceptable and 4 that it was perfectly acceptable. The intermediate ratings 2 and 3 were to be used for judgments that fell between these two extremes. The first five dialogues heard by participants were practice items, and after that the stimulus items presented pseudorandomly interspersed with 20 distractor sentences that had no relationship with the research question. Of these, four contained ungrammatical sentences; the purpose of including these was to ensure that participants were attending to the task. If any participant were to rate the ungrammatical sentences as acceptable, their responses would not be considered reliable. As discussed in [Appendix A](#), the ungrammatical fillers received a uniformly low rating (in the range 1.07–1.50).

The dialogues were recorded by two native speakers from the USA. They were graduate students in linguistics at the University of Potsdam, but were naive as to the goals of the experiment. The sentences they produced were checked for anomalies in intonation by a phonetician.

The experiment stimuli are described next. Three focus-sensitive operators were tested: *only*, *also* and *even*. These were crossed with four interveners: *only*, *also*, *even* and *nobody*. Nine combinations were chosen with the configuration shown in (2).⁴ The F0 contours for the nine target sentences are shown in [Appendix B](#).

- (2) Op1 ... [Op2 [_x ... F2 ... F1 ...]]
- (i) Op1: also Op2: only
 - (ii) Op1: also Op2: nobody
 - (iii) Op1: also Op2: even
 - (iv) Op1: only Op2: also
 - (v) Op1: only Op2: nobody
 - (vi) Op1: only Op2: even
 - (vii) Op1: even Op2: only
 - (viii) Op1: even Op2: nobody
 - (ix) Op1: even Op2: also

The purpose of the experiment was to determine the acceptability of the target structure under the target interpretation, not the acceptability of the target structure as such. Hence, the stimulus items were presented in a context that unambiguously fixed the interpretation to the association pattern we are interested in. (16) is the overall context for (17), the first test set. In the dialogue in (17), the second sentence instantiates the configuration (2) with Op1 = *also* and Op2 = *only*. We represent both regular focus and second occurrence focus with the subscript F in (17) and the following examples.

(16) Context

A and B are detectives in the San Francisco police force. They are building a case against the well-known director of a local bank. Their main evidence consists of a set of photographs and a video showing the suspect in incriminating circumstances. Their assistants are trying to find eye witnesses to the events taking place in the pictures. Unfortunately, there has been a leak to the press. A and B are trying to find out how the information could have gotten out.

(17) Target

A: You only showed [the photos]_F to Carol.

B: Right. I also only showed [the photos]_F to Robin_F.

[also ... [only [_x ... F2 ... F1 ...]] ...]

The same participants that rated the target items were also presented with control items. The purpose of the control item was to ensure that each participant's baseline acceptability for the interpretation of a semantically identical counterpart of the double-focus condition was known. Since we do not test for acceptability of structure, but rather for acceptability of a particular interpretation for that structure, the control items are paraphrases of the intended interpretation of the corresponding target item, but in which the multiple-focus configuration was avoided. That is, the interpretation was kept constant but the structure attempting to convey it was changed. An example of the control items is (18), which is a paraphrase of the

target (17).

(18) Control

A: You only showed [the photos]_F to Carol.

B: Right. Another person that I only showed [the photos]_F to is Robin_F.

[another ... [only [... F1 ...]] ... F2 ...]

The presentation of the control sentences was carried out in a separate session, this session being separated from the first by 4 weeks. In order to control for any effect of presentation order, half the participants saw the target stimuli in the first session and the control stimuli in the second, and the other half saw the targets and controls in the opposite sequence. We separated the presentation of the target stimuli from the control stimuli because showing both sentences in the same session could possibly introduce a priming effect. For example, presenting the semantically identical items (17B) and (18B) in the same session could bias the participants' judgment of whichever item occurred second. By separating out the targets and controls into separate sessions, we were able to avoid this possible bias.

3.2 A note on the dependent measure: gradient v. categorical grammaticality ratings

It is necessary here to briefly explain the interpretation of the dependent measure that we adopt in this paper. As mentioned above, we used a 4-point scale to obtain a judgment from participants about the grammaticality status of the theoretically interesting constructions. Due to the controversy in the literature about multiple-focus constructions, we expected the response to be gradient. We treat the gradient response in the experiment as an approximation of the (arbitrary) binary distinction of grammatical v. ungrammatical that is often used in linguistics. The only reason for this reductionist interpretation is that the theoretical debate we address in this paper is centered around a binary empirical decision—is the multiple-focus configuration grammatical or not?

3.3 A note on the statistical analysis

Data analysis was carried out using the linear mixed-effects (multilevel) model or LME (Bates and Sarkar 2006) available as the package `lme4` in the R programming environment (R Development Core Team 2006). In the pairwise comparisons (discussed below), participants were treated as a random factor (sometimes referred to as random effect) and target v. control as the fixed factor (or fixed effect). LME models have several advantages over traditional repeated-measures analyses of variance (ANOVA) and are becoming standard in experimental research, including psycholinguistics. This is evident from several recent psycholinguistics articles (e.g. Quené & van der Berg 2001, 2004; Bresnan *et al.* 2007; Oberauer & Kliegl 2006; Vasishth & Lewis 2006) and books (e.g. Snijders & Bosker 1999; Baayen 2008) that demonstrate the many advantages of this technique (see <http://lme4.r-forge.r-project.org/bib/lme4bib.html> for a complete bibliography spanning various experimental domains).

LMEs are beginning to replace the traditional repeated-measures ANOVA for several reasons. One is that

the computational tools they rely on (e.g. Monte Carlo Markov Chain techniques) have become feasible relatively recently; another is that the traditional by-participants and by-items (and Min-F) calculation of ANOVA is not necessary in LMEs because participant and item-level variation can be taken simultaneously into account in the model. This considerably simplifies the presentation and interpretation of results (Quené & van der Berg 2001) and increases statistical power (Baayen 2008).

Some further important properties of LMEs are relevant for psycholinguistic research. For example, they are more flexible when modelling diverse sources of heterogeneity and correlation, and they are able to model unbalanced and incomplete repeated-measures data. Since lack of balance (due, e.g. to missing data points) is quite common in psycholinguistic data (e.g. in the present experiment three participants failed to complete the second session), LMEs are an important alternative to traditional methods (such as introducing various corrections in ANOVA, or dropping the incomplete data points) because they result in greater statistical power. In order to demonstrate the differences between mixed-effects modelling and traditional repeated-measures ANOVA, we computed all analyses using traditional repeated-measures ANOVA as well (participants with missing data were removed from the analysis). As shown below, in several pairwise comparisons, the ANOVA did not show a significant difference although LME did. In order to allow the reader to take a closer look at the details of the data analysis, the complete dataset and code used for statistical analysis are released along with this paper; they are downloadable from <http://www.ling.uni-potsdam.de/~vasishth/BeckVasishth/>. Also released at the same website are (a) all sound files containing the targets, controls and fillers and (b) PDFs showing the F0 pitch contours for the targets. The F0 pitch contours are also included in [Appendix B](#).

3.4 Results

In order to compare the relative acceptability of each of the focus configurations, it was necessary to compare the response of each target with its control. This results in nine pairwise comparisons.

[Figure 1](#) shows the mean ratings for the target and control conditions. Overall, control items were rated significantly better (mean 2.35) than targets (mean 1.93), $t = 3.96$, $P < 0.01$ [repeated measures ANOVA, by-participants $F_1(1,12) = 9.15$, $P = 0.01$, $MSE = 10.26$, by-items $F_2(1,8) = 3.45$, $P = 0.10$, $MSE = 2.97$]. The LME model was fit with target v. control as a fixed factor, and participants and items as crossed random factors.

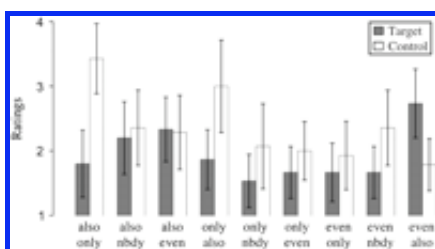


Figure 1 Mean ratings for target and control conditions for the nine pairs. A rating of 1 corresponds to the judgement "completely unacceptable" and the rating 4 corresponds to the judgement "perfectly acceptable".

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We turn next to pairwise comparisons between each target and its corresponding control. Presented in [Figure 2](#) are the regression coefficients and 95% confidence intervals based on the LME analysis (participants were treated as random factors). A coefficient whose confidence intervals do not cross the zero line is statistically significant. The meaning of a significant coefficient with a positive sign is that the control was rated better than the corresponding target; a negative coefficient means that the target was rated significantly better than the control. We present the results as regression coefficients rather than conventional t and P values but, as mentioned earlier, we also present the results of a conventional ANOVA for each comparison (note that for each target–control comparison, the ANOVA refers to by-participants analyses; there is only one item in each comparison).

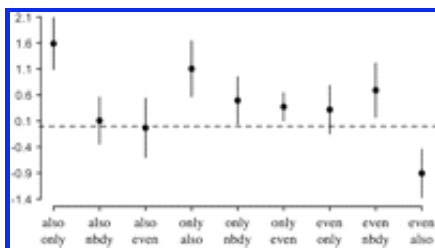


Figure 2 Estimated coefficients and 95% confidence intervals for the nine target–control comparisons; the regression was carried out using linear mixed-effect LMEs models, with the target–control as a fixed effect and participants as random effect. The interpretation of the graph is discussed in the text.

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The LMEs analysis showed that, consistent with Theory A but inconsistent with Theory B, several of the double-focus configurations were rated significantly worse than the corresponding controls. These were *also-only* [$F(1,12) = 32.88, P < 0.01, \text{MSE} = 15.39$], *only-also* [$F(1,12) = 14, P < 0.01, \text{MSE} = 7.54$], *only-nobody* [this comparison was marginal in the conventional repeated measures ANOVA, $F(1,12) = 3.6, P = 0.08, \text{MSE} = 1.38$], *only-even* [$F(1,12) = 7.5, P = 0.01, \text{MSE} = 0.96$] and *even-nobody* [this was not significant in the conventional ANOVA $F(1,12) < 1$]. In the *even-only* comparison, the target double-focus configuration was marginally worse than the control [$F(1,12) = 2.54, P = 0.13, \text{MSE} = 0.96$], and no significant differences were found between *also-nobody* and *also-even* ($F_s < 1$). Finally, *even-also* was rated significantly better than the control [$F(1,12) = 11.52, P = 0.005, \text{MSE} = 4.65$]; however, upon closer examination, it was found that the control had an incorrect name in the critical sentence (rendering it inappropriate in the context in which it was presented); this would explain the lower rating for the control.

3.5 Discussion

To summarize the results, five of the nine comparisons showed that double-focus configurations were rated worse than their corresponding controls, and one comparison was rated marginally worse than its control. Of the remaining three comparisons, two did not show any significant effects, and the remaining comparison showed that the control was rated worse than the target, but this is probably due to the error in the control item. Thus, only eight comparisons are relevant for interpreting the results.

No target item received a mean rating above 2.69 (*even-also*), which is approximately the middle of the rating scale. This suggests that the multiple-focus configuration (2) tends towards being unacceptable rather than acceptable.

Thus, we may conclude that the degraded status of the target items is to a significant extent due to the configuration (2), not the nature of the meaning conveyed. A further study might clarify whether conditions *also—even* and *even—also* are really better than the other instances of the multiple-focus schema (2). It is not expected from the representative theories discussed in this paper (Rooth 1992; Wold 1996) that the choice of focus operator should matter. If, however, Beaver & Clark (2003) are right and not all focus-sensitive operators are alike, then there is a possibility that a more nuanced differentiation is necessary for multiple-focus configurations. This is an empirical question that must be left for future research.

The main purpose of this study was to empirically address the question whether the multiple-focus configuration violates a principle of grammar. Our answer is yes. However, as a reviewer points out, our results are also consistent with an alternative explanation: focus association in multiple-focus configurations might reflect a constraint on human sentence comprehension that is *independent* of the grammar of focus interpretation. We discuss this possibility next.

The comprehension process underlying association with focus is an instance of a more general and very well-studied psycholinguistic phenomenon: dependency resolution. Under one commonly held view (Just & Carpenter 1980, 1992), (Van Dyke & Lewis 2003; Lewis & Vasishth 2005; Lewis *et al.* 2006; Van Dyke & McElree 2006; Vasishth & Lewis 2006), at least some types of dependency resolution can be characterized as a cue-driven retrieval process (for related work, see Gibson 1998, 2000; Grodner & Gibson 2005; Gordon *et al.* 2006). To take a concrete example as an illustration, in the computational model of parsing presented by Lewis & Vasishth (2005), a verb seeking an argument (such as its subject) sets cues—a specification of particular feature-values such as person, number, gender, animacy and/or case agreement—in order to retrieve the target argument. The speed with which this retrieval is completed (the retrieval latency) and the likelihood and/or latency of a successful retrieval are determined by, among other factors, the number of other nouns in working memory that have similar features. The greater the number of similar nouns, the more difficult it is to retrieve the target noun. This process of cue-based retrieval has been shown to be quite generally applicable in explaining constraints on dependency resolution. For example, the dependency resolution needed for processing certain kinds of negative and positive polarity items has also been argued to be subject to similar constraints during online processing (Vasishth *et al.* 2008). Thus, a cue-based retrieval mechanism can also be invoked to explain the increased difficulty in comprehending

multiple-focus configurations.

Let us revisit an earlier example to see how such a processing account would work. Consider again (10b), repeated below:

(10b) We also only introduced [Marilyn]_F to [Bob Kennedy]_F.

The prosodically focused phrase *Bob Kennedy* would set retrieval cues for a c-commanding focus operator in order to complete the dependency. However, at this point we need to decide what these retrieval cues should be. In order to derive the predictions of this processing account, we have no choice but to consult semantic theory. Semantic theory suggests two alternatives: Theory A and B. Under Theory A, the search for a c-commanding focus operator would result in greater retrieval difficulty (or outright retrieval failures) because there are two candidate focus operators. This greater retrieval difficulty could result in the lower acceptability ratings we found (assuming that online processing difficulty is reflected in offline acceptability judgments—we return to this point below). By contrast, under Theory B, each focus operator has a unique index associated with it that corresponds to the index for the focused words. Under this assumption, the focused phrase would seek out a focus operator with a unique index, and since there is only one focus operator in memory that has this particular index, retrieval latency and accuracy should be faster. This would (contrary to our findings) be reflected in higher acceptability ratings.

The important point here is that even if we were to assume that the underlying explanation for our results lies in processing, the assumptions of the processing account would still derive from assumptions about the underlying grammatical constraints. Differently put, there is no processing account available without invoking the assumptions of Theories A and B. Yet another way to look at this is that when we say that the effect is due to grammatical constraints, we do not provide a process model of how these grammatical constraints are used in online comprehension. Adding such a process model, as we do in the sketch above, would couple the grammatical mechanism with well-defined processing steps, but this does not entail that the explanation for the effect lies in processing. This is what we mean when we say that the best explanation for the results presented in this paper lies in grammatical rather than processing constraints. We are not at this point aware of a pure processing explanation that would make no reference to the mechanisms implied by Theory A or Theory B.

► 4. CONCLUSIONS

Since five out of the eight relevant comparisons show lower ratings for the double-focus configurations (and one showed marginally lower ratings), the evidence is consistent with Theory A but not with Theory B. There appears to be something wrong with the configuration in (2). A theory of focus interpretation should predict

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that such structures are ungrammatical. Rooth (1992) provides one such theory. A ban on (2) also follows a more general pattern of alternative evaluation observed in Beck (2007) (called the *General Minimality Constraint*), which states that the evaluation of alternatives cannot skip an intervening focus-sensitive operator.

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(2) Op1 ... [Op2 [_X ... F2 ... F1 ...]]

An interesting further question concerns free focus. Rooth's (1992) theory makes no difference between a focus used by an operator like *only* and a focus that is evaluated purely for discourse purposes. An interesting example is found in Büring (2006).

- (19) What did John only eat in PARIS? (Schwarzschild p.c. from Büring 2006)
- # John only ate crepes in PARIS.
 - # John only ate CREpes in Paris.
 - It's CREpes that John only ate in Paris.

In this example, the VP contains a focus that is interpreted by VP adjoined *only*, namely *Paris*. At the same time, the VP contains an object NP that needs to be focused in order to satisfy the requirements on question/answer coherence. Whatever operator evaluates question/answer coherence (we call it Q/A_C here) will therefore play the role of Op1 in a structure instantiating our schema (2):

(19') [_{IP} Q/A_C [_{VP} John only_D [_{VP} ate CREpes_{F1} in Paris_{F2}]]]]

The example is unacceptable, just like our multiple-focus data in the experiment. Büring assumes that focus evaluation is selective (as in the systems of Krifka 1991, Kratzer 1991 or Wold 1996), not unselective (as in Rooth 1992). He predicts the ungrammaticality from the impossibility of obeying the relevant constraints on prominence:

- (20) Focus Prominence (FP):
If P is the domain of a focus-sensitive operator O, the most prominent element in P is a focus of O.

The domain of *only* is the VP, so the most prominent element in the VP should be *Paris*. The domain of Q/A_C is the IP, and the most prominent element in the clause should be *crepes*. Since the VP is contained in the IP and *crepes* is contained in the VP, it is impossible to meet both restrictions at the same time. Büring's constraint will also rule out structures instantiating (2). He notes, however, that the contrast between the unacceptable (19) and the acceptable (21) poses a problem. A discourse-level operator needs to evaluate the contrast relation between *grow* and *eat*, crossing over the dependency between *only* and *rice*—another

instance of (2). This time, the example is fine, however.

- (21) a. People who grow rice only EAT rice.
 b. [CONTRAST_C [... [only_D [eat_{F1} rice_{F2}]]]]]

It is not clear what distinguishes the *rice* sentence from the *crepes* sentence. See Büring (2006) and Rooth (2006) for further thoughts on the subject. Data such as (19) and (21) suggest that question/answer pairs and contrast be included in future systematic experimental studies as well.

The discussion shows that multiple-focus data like the ones investigated in this study play a crucial role in the lively theoretical debate of the form/meaning relationship and the interpretation of focus. At the same time, the facts are far from clear. We hope to have contributed a crucial piece in the empirical foundation for future theoretical development.

► Appendix A

Instructions for the experiment

Welcome. Thank you for participating in this Experiment.

You will hear a dialogue between two detectives. The background of the dialogue is shown below. Please read it carefully. You also have a sheet of paper in front of you with this background information. You can look at it during the experiment if you need to.

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There is a male and a female detective in the San Francisco police force. They are building a case against the well-known director of a local bank. Their main evidence consists of a set of photographs and a video showing the suspect in incriminating circumstances. Their assistants are trying to find eye witnesses to the events taking place in the pictures. Unfortunately, there has been a leak to the press. The two are trying to find out how the information could have gotten out.

When you hear the response of the female detective, you need to rate her response as grammatical or ungrammatical. If you consider it fully grammatical, click on 4, and if you find it completely ungrammatical, click on 1. You can choose an intermediate number if you feel that it is somewhat grammatical or ungrammatical.

Examples:

Example 1: This sentence is a good English sentence. (fully grammatical)

Example 2: Wrong the sentence of course is. (totally ungrammatical)

Example 3: This sentence seems in a way to be neither totally grammatical nor totally

ungrammatical. (somewhat ungrammatical)

Let's try some practice ...

[Four practice trials follow.]

If you have any questions, ask the experimenter now.

Otherwise, you may begin the experiment.

The context sentence (a), the target sentence (b) the control (c):

- (1) a. You only showed the photos to Carol.
b. Right. I also only showed the photos to Robin
c. Right. Another person I only showed the photos to is Robin.
- (2) a. You showed the photos to Carol. Did you also show the movie to her?
b. No. I only also showed the movie to Robin
c. No. The only person that I also showed the movie to is Robin.
- (3) a. You told nobody about the photos.
b. No. I only told nobody about the movie.
c. No. It's only the movie that I told nobody about.
- (4) a. You told nobody about the movie.
b. Right. I also told nobody about the photos.
c. Right. Another thing I told nobody about is the photos.
- (5) a. You told nobody about the movie.
b. Right. I even told nobody about the photos.
c. Right. Even the photos I didn't tell anybody about.
- (6) a. You only showed the photos to Carol.
b. Right. I even only showed the photos to the boss.
c. Even the boss, I only showed the photos to.
- (7) a. You showed the photos to Carol.
b. Yes. I also showed the movie to her. I even also showed the movie to Carol's assistant.
c. Yes. I also showed the movie to her. Even her assistant I showed the photos to as well.
- (8) a. You showed the photos to Carol's assistant. You even showed the movie to him.
b. No. I only even showed the movie to Carol.
c. No. The only person I even showed a movie to is Carol.
- (9) a. You showed the pictures to Carol. You even showed her the movie.
b. Yes. I also even showed the movie to Robin.
c. Yes. Another person I even showed the movie to is Robin.

Fillers:

Note that fillers 16, 17, 19, and 20 contain either odd or ungrammatical sentences. These items were included in order to make sure that our participants were attending to the task; the expectation was that they would rate these fillers as unacceptable. The mean ratings for all fillers are provided with the raw data and code from the website <http://www.ling.uni-potsdam.de/~vasishth/BeckVasishth>. As expected, these ungrammatical items were rated as unacceptable (in the range 1.07–1.50). by participants.

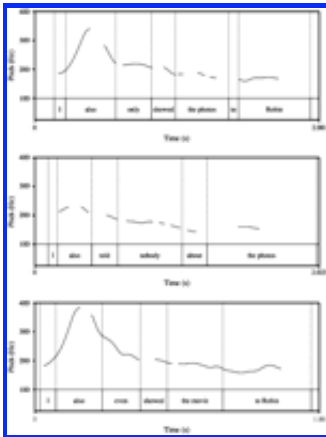
- (1) a. You did talk to the fellow from CNN about the photos.
b. Right. But I didn't mention what was in them.
- (2) a. You didn't bring up the photos and the movie at the press conference, did you?
b. No, I cleverly avoided mentioning those when outlining the progress we've made.
- (3) a. You might have said something to your husband about it, and he may have mentioned it to someone.
b. Right, I did tell him. But he never talks about an ongoing case of mine with anyone.
- (4) a. You said yesterday that the New York Times reporter was talking to the bank guard for a long time.
b. Right, but I can't imagine how he would know about the photos and the movie.
- (5) a. So, do you think the information was leaked by one of our assistants?
b. No, I am sure they'd never talk about this to the press or anyone else.
- (6) a. You really know for sure that nobody has access to our desk when we are out for lunch?
b. Yes, there are only two keys for it and we have them.
- (7) a. So, do you think there could have been someone at your computer?
b. Unlikely. Nobody knows the password.
- (8) a. Do you remember that guy who sat in the cafe next to us? He might have heard something.
b. Maybe, but I don't think he has anything to do with the case.
- (9) a. You think the courier made duplicates of the pictures?
b. No, I have known him for years. We can trust him.
- (10) a. You sent the important files by mail, didn't you?
b. No, I always deliver them personally.
- (11) a. You wanted to ask your special informant if he knows something.
b. Right. I asked him. He has no idea at all.
- (12) a. Do you think we'll end up working on this case forever?
b. No, I think we'll work it out pretty soon.
- (13) a. You talked to that talkative eyewitness on Tuesday.
b. Possibly. But the news media would never publish uncorroborated information.
- (14) a. You made some notes the other day. Has anyone seen them?
b. No, I've been shredding them as usual after inputting them into the computer.
- (15) a. So, are you sure no-one has been eavesdropping on us?

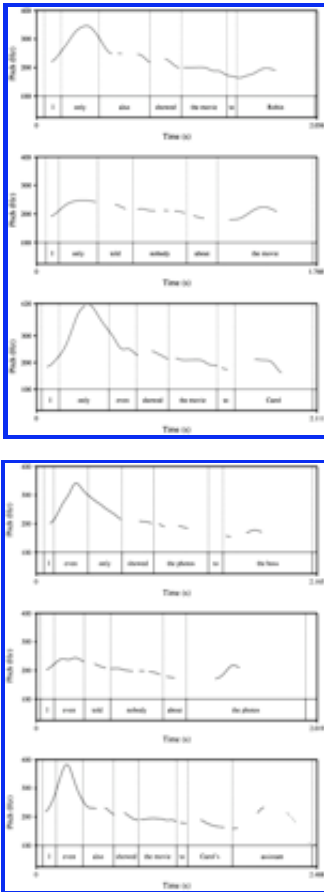
- b. Well, you can never be sure about that, but probably not.
- (16) a. You can ask the reporter how he got the information?
b. Yes, I could do that. Although is he not going to tell me?
- (17) a. So, do you think our boss is involved?
b. I think not he is.
- (18) a. You know anyone else from the department who could be interesting for us?
b. Yes, there is sometimes this strange guy from the other side of the building.
- (19) a. You have shown the pictures to your daughter, right?
b. I did never at all show her the pictures.
- (20) a. You think the technician has talked about the video?
b. I don't know. He is to our department new.

► Appendix B

F0 contours for the nine multiple-focus pairs:

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Notes

¹ Rooth (1985^[1], 1992^[2]), Kratzer (1991)^[3], Krifka (1991)^[4]. See Geurts & van der Sandt (2004) for a differing analysis, and that issue of *Theoretical Linguistics* and Sauerland (2005)^[5] for discussion. We present the discussion in terms of what we take to be the most standard framework. We do not think that this is crucial for the theoretical point at hand. ^[6]

² The term ‘focus evaluation’ is from Beck (2007)^[7]. It is preferred to the term Rooth (1992)^[8] uses, ‘focus interpretation’, because the latter could equally well refer to the role that focus has of introducing alternatives, while we want to talk about what happens when these alternatives are used in some further semantic calculation. Focus evaluation is also preferred over ‘association with focus’ in our theoretical discussion because ‘association’ tends to be used to describe intuitively available interpretations for operators like *only*, *always* and *most*. We want to remain neutral between a theory of direct association and an indirect one like Rooth's (1992), and we want to specifically refer to a mechanism of the grammar, not an interpretive effect. ^[9]

³ Note that ‘Marilyn’ in (10b) bears an second occurrence focus (SOF): it does not typically carry a pitch accent, but the semantically required F feature is realized phonologically by more subtle means like duration. Compare, for example, Rooth (1996b)^[10] and Beaver *et al.* (2007)^[11] on SOF. The issue of SOF is not itself relevant for us; we will assume, in accordance with the recent literature, that SOF is formally marked. We will use F to indicate that. ^[12]

⁴ We tested negation (in the shape of ‘nobody’) as an intervener because it is a well-known problematic intervener (e.g. Beck 2006^[13]), but we did not test it as an associating operator because it is not clear that negation associates with focus (compare the discussion in Rooth 1996a^[14]). Hence the nine combinations. ^[15]

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