What's included in the set of alternatives? Psycholinguistic evidence for a permissive view

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Abstract. According to a standard permissive view, the set of alternatives consists of various possible replacements of a focused expression (Rooth 1985, 1992). On the other hand, a more restrictive view assumes that certain alternatives are excluded from consideration such as elements which do not form a partition (e.g., Wagner 2006, 2012). I will try to adjudicate between these two theories by looking at the question which elements listeners consider as part of the alternative set. The data presented here suggest that listeners consider a broad set of possible replacements of a focused expression even when a set of particular elements is enumerated contextually. Therefore, the data are most in line with a permissive view of alternative sets such as the one proposed by Rooth (1985, 1992). Albeit, listeners do not consider the entire focus semantic value but rather a *partially-restricted set* – an intermediate set between the focus semantic value and the actual/relevant set of alternatives.

Keywords: Alternative set, focus semantics, focus particles, contextual restriction

1. Introduction[1]

The function of focus is to evoke a set of alternatives. However, it is an open theoretical question which elements are included in the alternative set and at which level restriction applies (see especially Rooth 1992; Blok & Eberle 1999; Cohen 1999 and Umbach 2001).

In his paper entitled *A note on contrast*, Katzir (2013) compares the standard Roothian view of alternatives to a more restrictive one. I will follow Katzir in using the terms *permissive* and *restrictive* here. On the permissive view advocated by Rooth (1985, 1992), the formal set of alternatives contains various possible replacements of a focused expression and restriction applies at the level of pragmatics (independent of compositional semantics). On a restrictive account, on the other hand, certain alternatives are excluded from consideration. For example, according to Wagner (e.g., Wagner 2006, 2012), alternatives need to form a partition/be mutually exclusive. His proposal is motivated by the examples in (1) listed below (see Katzir 2013 for a detailed discussion; examples are taken from Wagner 2006).

(1) a. John only likes $[\text{red}]_F$ convertibles
    b. John likes blue convertibles
    c. John likes cheap convertibles

Wagner points out that the sentence *John only likes* $[red]_F$ *convertibles* negates that John likes blue convertibles but does not necessarily state anything about cheap convertibles. In other

[1] I would like to express my gratitude to Manfred Krifka, Brian Leahy, Yaron McNabb, Edgar Onea, Jacopo Romoli, Katharina Spalek, Jack Tomlinson, Judith Tonhauser, Carla Umbach and Malte Zimmerman for helpful comments on this work. The research reported here is part of my dissertation with some modifications (see Gotzner 2015, Chapter 5).

words, it seems that (1)-c is ignored as an alternative to (1)-a. Therefore, Wagner proposes that only those elements which are mutually exclusive can form part of an alternative set (e.g., *red* and *blue* but not *red* and *cheap*). His account relies on the assumption of contrast between elements of the alternative set.

In the standard view of alternative sets by Rooth (1992), on the other hand, alternatives simply need to match the focused expression in semantic type. For the given example, *cheap* is a potential alternative to (1)-a because it can replace the focused element *red*. In the framework of focus interpretation proposed by Rooth (1985, 1992), a focused expression has two meaning components, an ordinary value and a focus semantic value. Consider the following example presented in (2) (Rooth 1992, p. 2).

(2) a. Mary likes [Sue]$_F$
b. Ordinary value $[[\cdot]]^o$: like (Mary, Sue)
c. Focus semantic value $[[\cdot]]^f$: like (Mary, x | x ε E), where E is the domain of individuals

The ordinary value of the sentence *Mary likes [Sue]$_F$* corresponds to its usual meaning as derived by compositional semantics. The focus semantic value is derived by replacing the focused element with other suitable elements of the same semantic type (Mary likes *x*). The intuition is that focus evokes a set of alternatives: In the given example this amounts to a set of persons Mary might like. By definition, the focused element is always a subset of the focus semantic value and it needs to contain an element distinct from the focused element (in the case of focus marking). However, the semantics of focus does not involve contrast in the sense that alternatives are excluded or negated on this view (see also Büring 2008 for a discussion of the notion of contrast in alternative semantics).

Rooth (1992) further spells out the theory of focus and proposes constraints on the set of alternatives. In particular, he assumes that the actual set of alternatives is not identical to the focus semantic value but it is a subset of it, which is further constrained by context. Contextual restriction is managed by a free variable C in LF, whose domain of quantification is determined by pragmatics. Hence, on the permissive view restriction of the set of alternatives does not apply at the level of semantics or *a priori*. Further, focus particles like *only* do not quantify over the entire focus semantic value but rather over the contextually-restricted set of alternatives.

Katzir (2013) shows how the puzzle posed by Wagner's examples in (1) can be reconciled in the standard permissive view by eliminating contradiction. Here, I take a psycholinguistic approach to explore the question which elements are included in the alternative set. In particular, I will probe the question whether listeners consider only a contextually-restricted set of alternatives or rather a broader set of possible alternatives. The aim of the following analysis is to see which account, the permissive or restrictive, makes better empirical predictions concerning the question of how the set of alternatives is composed when listeners encounter a focused expression. There is no doubt that alternative sets need to be restricted in some way (see especially Rooth 1992; Blok & Eberle 1999; Cohen 1999 and Umbach 2001). Despite this fact, I will show that listeners have access to a broader set of alternatives rather than only the small contextually-restricted set.

The nature of this set is *partially-restricted*[2] in that listeners do not consider the entire focus semantic. I will conclude that the data are most in line with a permissive view of alternative sets.

2. Previous psycholinguistic studies on the retrieval of alternatives

2.1 Activation of alternatives in the lexical decision task

Recently, a growing interest in the cognitive reality of alternative sets has emerged and several psycholinguistic studies have provided evidence that listeners entertain alternatives upon processing focal information (Braun & Tagliapietra 2010; Fraundorf, Watson & Benjamin 2010, 2013; Kim 2012, 2015; Byram-Washburn 2013; Gotzner, Spalek & Wartenburger 2013; Spalek, Gotzner & Wartenburger 2014, Gotzner, Wartenburger & Spalek accepted and Husband & Ferreira 2015; see Gotzner 2015 for a detailed overview). Here, I focus on investigations using the lexical decision paradigm, which provide direct insights into the retrieval of alternatives. In this paradigm, participants hear auditory stimuli and are presented with letter strings on the screen. Their task is to indicate whether a given letter string is a word or not (e.g., APPLE vs. UNPER). Participants' reaction times to an existing word are taken to indicate to what extent this particular word is activated. Put differently, reaction times in the lexical decision reflect whether a word is already present in a listener's mind, referred to as priming.

In a pioneering study, Braun & Tagliapietra (2010) used the lexical decision paradigm to test whether intonational focus activates alternatives. In particular, they compared utterances realized with contrastive and non-contrastive intonational contours and asked participants to recognize unmentioned semantic alternatives and words unrelated to the focused elements. The results showed that contrastive intonation speeded up reaction times to alternatives as compared with unrelated items (priming effect). Interestingly, such a priming effect was not observed when the sentences were realized with a non-contrastive intonational contour. Therefore, the results provide evidence that contrastive intonation creates a representation of an alternative set when no such set is emumerated contextually.

2.2. Contextual alternatives and the retrieval of additional alternatives

Concerning the question which elements are included in the set of alternatives, a study by Gotzner et al. (accepted) provides some initial evidence favoring a permissive view of alternative sets along the lines of Rooth (1992) (see also Gotzner 2015, Chapter 4). In this study, we explored the question whether listeners consider additional unmentioned alternatives when we provide them with a contextual set of elements. Participants listened to short discourses that introduced a set of three elements and mentioned two of those elements again (see (3)).[3]

[2] I thank Judith Tonhauer for dubbing this term.

[3] The correction in the critical sentence was used to ensure that all elements were mentioned the same number of items and to smooth the discourse. Note also that the focused element in the critical sentence of speaker 2 is in narrow focus position since all other material is given in the utterance of speaker 1.

(3) Context sentence (speaker 1):
In der Obstschüssel liegen Pfirsiche, Kirschen und Bananen.
'In the fruit bowl, there are peaches, cherries, and bananas.'

Continuation sentence (speaker 1):
Ich wette, Carsten hat Kirschen und Bananen gegessen.
'I bet Carsten ate cherries and bananas.'

Critical sentences (speaker 2):
Nein, er hat nur /_ $[\text{Pfirsiche}]_F$ gegessen.
'No, he only/_ ate $[\text{peaches}]_F$.'

We varied whether the focus particle *only* or no particle appeared in the third critical sentence while the focused element was intonationally marked in both conditions (narrow focus). The rationale was that the computation of alternatives is necessarily involved with focus particles, because such particles grammatically depend on a set of alternatives (Rooth, 1992; see also Beaver & Clark, 2008). Therefore, we expected to observe stronger activation of alternatives and/or stronger competition among members of the alternative set with *only* compared to no particle. After exposure to the discourses, a target word appeared on the screen that was either a mentioned alternative (PEARS), an unmentioned alternative of the same semantic category (APPLES) or an unrelated word (SOCKS).[4] The items we tested were (possible) alternatives to the NP in narrow focus position.[5]

In the first experiment, participants performed a lexical decision task. The results showed that reaction times were fastest for mentioned alternatives, intermediate for unmentioned alternatives and slowest for unrelated items. These results demonstrate that (i) mentioned alternatives receive the highest amount of activation (by virtue of being mentioned and/or repeated) and that (ii) additional unmentioned alternatives become activated. In other words, listeners most strongly considered the mentioned alternatives, suggesting that these alternatives are the most relevant ones. Crucially, listeners also considered further possible alternatives. Moreover, we found that responses were slower in the condition with *only* compared to no particle referred to as an interference effect. This interference effect of the focus particle *only* indicates that identifying the relevant alternatives is subject to competition among members of the alternative set. Put differently, a comparison is being made among the set of possible alternatives.

In a second experiment, we further investigated (i) the question whether listeners consider additional unmentioned alternatives and (ii) the nature of the interference effects of focus particles. We used a probe recognition task, which is a variant of the lexical decision task. In this task, participants heard the same auditory discourses and were then asked to indicate whether a

[4] These items were matched in word length and frequency (see Gotzner et al. 2015 for details).

[5] It may be argued that focus projects to the VP level in the given examples. But in any case Breen, Fedorenko, Wagner, and Gibson (2010) present evidence that speakers and listeners reliably distinguish between narrow and broad focus.

word had appeared in the discourse or not. The probe recognition task requires listeners to create a mental model of the discourse and to match the given word with that model. So, participants need to compare the word they see on the screen with what they recall from the discourses. Results again showed that participants were slower at recognizing the mentioned alternatives as well as unmentioned alternatives in the condition with *only* compared to no particle. In contrast, such an interference effect of focus particles did not show for unrelated items. Hence, the results provided further evidence that listeners consider mentioned as well as unmentioned alternatives. Further, we found similar interference effects for the additive scalar particle *sogar* ('even') as with *nur* ('only') (see König, 1991 for a comparison of the two types of particles). This indicates that the observed interference effects are due to the grammatical dependence of focus particles on an alternative set and not the exclusive meaning of *nur* ('only'). Overall, the study showed that listeners entertain a set of mentioned and unmentioned alternatives and that focus particles induce additional competition among members of the alternative set.

We assume that these competition mechanisms ultimately help narrowing down the set of alternatives to its relevant members – the contextually-restricted set over which focus particles quantify. Crucially though, listeners initially consider a broader set of alternatives and the restriction of this set requires time (see Husband & Ferreira 2015). In sum, these previous experiments indicate that alternative sets are established by two mechanisms: (i) activation of a broad set of possible alternatives and (ii) subsequent restriction to relevant alternatives by competitive inhibition.

Strikingly, in Gotzner et al. (accepted) a set of three elements was listed in the context but nonetheless participants were considering additional unmentioned alternatives. This finding is consistent with the assumption of the permissive view that multiple possible replacements are part of the set of alternatives (Rooth 1992). However, an important caveat to this assumption is that the unmentioned alternatives used in Gotzner et al. were of the same semantic/taxonomic category as the focused element. One might therefore argue that the observed effects were heavily based on general semantic priming mechanisms and not necessarily based on the computation of/access to alternatives. The effect of focus particles ameliorates this concern to some extent but to inform the permissive/restrictive debate we would like to rule out the semantic relatedness factor. To provide further insight on the debate, I will present an additional analysis of the unrelated items used in Gotzner et al. The goal is to see whether such items are considered as part of the alternative set in certain contexts.

3. Novel analysis: Are unrelated items considered as part of the alternative set?

3.1. Rationale

In the following, I will make a similar restriction argument for the unrelated items used in Gotzner et al. (accepted) as for Wagner's examples of mutually exclusive adjectives (presented in (1) above). Consider the examples in (4).

(4) Context: Anna wanted to buy apples, bananas and cherries at the fruit store. However, the store was almost empty.
a. She only got to buy [apples]$_F$.
b. She got to buy pears.
c. She got to buy socks.

The sentence (4)-a *She only got to buy apples* negates the alternative (4)-b that Anna bought *pears.* However, it does not make a statement about other types of things Anna could have bought like *socks*. So, (4)-c is again ignored as an alternative to (4)-a similar to what we saw in (1) for adjectives. This is also evident in the fact that the discourse could be continued by saying *In fact, she also got to buy socks* without any contradiction (though some information has to be accomodated here). Hence, on the restrictive view *socks* is not an alternative to *apples*. On a permissive view, on the other hand, *socks* would be included in the set of alternatives since it is a possible replacement of the focused element *apples*.

In Gotzner et al. (accepted), about half of the unrelated items were possible replacements of the focused element while the other half were not.[6] Consider the two examples displayed below:

(5) **Possible replacement:**
Im Katalog sind Hemden, Hosen und Jacken.
'There are shirts, trousers, and jackets in the catalogue.'

Ich wette, Matthias hat sich Hemden und Hosen gekauft.
'I bet Matthias has bought shirts and trousers.'

[6] A closer inspection of other previous psycholinguistic studies revealed that different types of unrelated targets have been used. Braun and Tagliapietra (2010) and Byram-Washburn (2013) used unrelated items that could replace the focused expression. In Husband and Ferreira (2015), on the other hand, most unrelated items could not replace the focused elements (e.g., *The grandmother purchased some [fabric]$_F$ for her new project*, unrelated item: HOLY).

Nein, er hat sich nur /_ [Jacken]$_F$ gekauft.
'No, he only /_ bought [jackets]$_F$.'

Unrelated item = LYCHEES

(6) **No replacement:**
Auf der Wiese sind Bienen, Fliegen und Mücken.
'There are bees, flies, and mosquitos on the meadow.'

Ich wette, Karl hat Mücken und Bienen gefangen.
'I bet Karl has caught mosquitos and bees.'

Nein, er hat nur /_ [Fliegen]$_F$ gefangen.
'No, he only/_ caught [flies]$_F$.'

Unrelated item = SOFAS

In (5), the unrelated item *lychees* can potentially replace the focused expression in the critical sentence 'No, he only/_ bought [jackets]$_F$' even though the sentence might not make a statement about *lychees*. Depending on the account, permissive or restrictive, the *lychees* in (5) can be considered as an alternative to *jackets* or not. In (6), on the other hand, the unrelated item *sofas* cannot replace the focused element in the critical sentence 'No, he only/_ caught [flies]$_F$'. Hence, it is not an alternative to *flies* on either of the two accounts.

According to Rooth (1985, 1992), the focus semantic value is derived by substituting the focused elements with elements of the same semantic type. This implies that unrelated items could be part of the alternative set if they can replace the focused expression. Note that the theory does not state that elements of the alternative set are part of the same semantic/taxonomic category. For example, imagine the scenario presented in (7).

(7) Context: On Peter's shopping list, there is shower gel, apples and bread. The store he went to was almost empty.
He only got to buy [bread]$_F$.

In the context of a shopping list with shower gel, apples and bread the sentence *He only got to buy [bread]$_F$*, asserts that Peter did not buy shower gel or apples. The items of the list are not part of the same taxonomic category but nevertheless *shower gel* is a potential alternative because it can be inserted in the sentence frame *Peter bought x* (see Byram-Washburn 2013 for experimental evidence that alternative sets can be created by contextual mention of items from different taxonomic categories).

Crucially, the unrelated items used in Gotzner et al. (accepted) were not even mentioned in the context sentences. Since the context sentences introduced a specific semantic category and a specific contextual setting, items that are unrelated to the focused element or the context might

not be relevant. However, in Rooth (1992) no explicit distinction is made between unmentioned alternatives of the same taxonomic category and unrelated possible alternatives. Therefore, we may predict that unrelated possible alternatives are activated as well.

In the analysis presented below, I coded the unrelated items used in Gotzner et al. (accepted) according to whether they were possible replacements of the focused element in the critical sentences or not. I included this binomial factor in an additional analysis of the lexical decision data. The lexical decision data were used in order to assess the difference in activation of unmentioned (semantically related) alternatives and unrelated possible alternatives/replacements. The purpose of this additional analysis was to see whether listeners consider such unrelated possible replacements as part of the alternative set.

3.2 Predictions

For unrelated items which are not a possible replacement of the focused expression both accounts, the permissive and the restrictive account, make the same prediction, since these items are no potential candidates for a given alternative set. In particular, we expect to observe the same pattern of results presented in Gotzner et al. (accepted): Mentioned alternatives should be recognized fastest, unmentioned alternatives intermediate and unrelated items slowest.

The critical comparison adjudicating between the permissive and the restrictive account is the recognition of unrelated possible replacements as compared with unmentioned alternatives (the elements of the same taxonomic category as the focused element). On a standard permissive account, such unrelated possible replacements should pattern along with the unmentioned alternatives, indicating that such items are activated/considered as part of the alternative set. The restrictive account, on the other hand, does not predict such a priming effect for unrelated items, so these items should be recognized slower than the unmentioned alternatives.

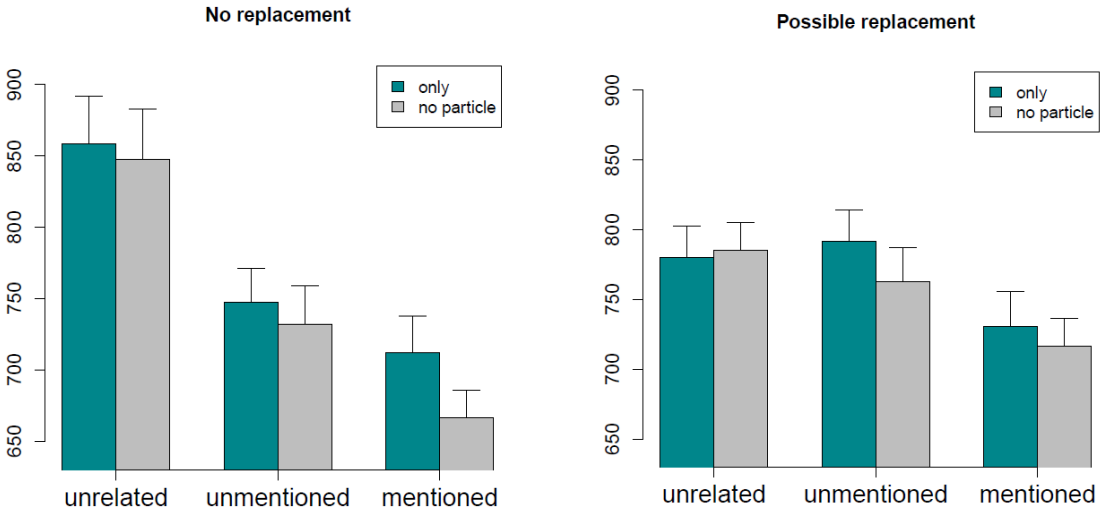
3.3.Coding

Three coders (a trained research assistant, a naive native German speaker and myself) coded the unrelated items according to whether they could replace the focused expression in the critical sentences or not. Only those items where judgments of the three coders converged were included in the analysis. Sixteen of the target words were possible replacements, eleven were not and three could not be clearly categorized. An additional binomial variable *possible replacement* (yes/no) was included in a mixed model analysis.

3.4. Results

Figure 1 shows the mean RTs across particle condition and target type. The left column presents items that could not replace the focused element and the right column shows possible replacements.

Figure 1: Mean RTs across target types for possible and non-replacements (lexical decision, error bars represent standard errors). Unrelated items are neither related to the focused expression nor context whereas mentioned and unmentioned alternatives are semantically-related to the focused expression.



I fit a series of mixed models following the procedure described in Baayen (2008). In the analysis, I included the factors particle condition (*only* vs. no particle), target type (mentioned, unmentioned, unrelated), trial number and the additional binomial factor possible replacement/no replacement as well as random effects for participants and items and random slopes for trial number. Possible replacements of the condition without a particle of the unmentioned alternatives were chosen as the baseline level. I only included an interaction term of the factors replacement and target type. The three-way interaction between particle condition, replacement and target type did not contribute to model fit (χ^2 (5) = 7.18, p = .20). 50 additional outliers were removed from the final model based on the distribution of observed and fitted values.

The main effect of *only* was not significant (p = .13), probably due to the fact that there were less items and observations in this model compared to the one by Gotzner et al. (accepted). As observed with the original data set, there was a significant difference between unmentioned and mentioned alternatives (t = -5.67, sd = .013, p < .0001). Interestingly, however, the difference between unmentioned alternatives and unrelated items was not significant (p = .74), indicating that unrelated possible replacements were recognized equally fast as unmentioned alternatives.

We were specifically interested in the effect of the variable replacement. The model revealed a main effect of the variable replacement: possible replacements were recognized faster than non-replacements ($t = -2.49$, $sd = .029$, $p < .05$). Critically, there was also an interaction between the unmentioned alternatives and unrelated items concerning the factor replacement ($t = 7.78$, $sd = .02$, $p < .0001$). This interaction indicates unmentioned alternatives were recognized faster than unrelated non-replacements while there was no such difference between unmentioned alternatives and unrelated possible replacements (as shown by the overall comparison presented above).

Finally, there was an interaction between mentioned alternatives and unmentioned alternatives concerning the replacement factor ($t = 2.2$, $sd = .02$, $p < .05$), reflecting that the difference between mentioned and unmentioned alternatives was bigger for items categorized as possible replacements. This interaction might be due to the fact that the data set was not perfectly balanced (there were 16 possible replacements and 11 non-replacements) but it is not of theoretical relevance. The results of the mixed model are displayed in Table 1.

Table 1: Mixed model replacement analysis (n = 1696, log-likelihood = 484.2)

	Estimate	Lower Bound	Upper Bound	pMCMC
(Intercept)	6.5931	6.5343	6.6479	0.0001
Only	0.0121	-0.0039	0.0283	0.1396
Mentioned	-0.0742	-0.1007	-0.0480	0.0001
Unrelated	-0.0047	-0.0303	0.0218	0.7444
No replacement	-0.0727	-0.1271	-0.0155	0.0106
Trial number	-0.0016	-0.0021	-0.0011	0.0001
mentioned: no replacement	0.0444	0.0033	0.0853	0.0326
unrelated: no replacement	0.1609	0.1179	0.2006	0.0001

3.5. Discussion

The additional analysis of the lexical decision data replicated the effect that mentioned semantically-related alternatives are recognized fastest. Interestingly, it showed that unrelated replacements of the focused elements were recognized equally fast as unmentioned semantically-

related alternatives, suggesting that listeners considered a broader set of alternatives rather than a limited one. The analysis further revealed that items that could not replace the focused expression were recognized slowest, indicating that such items are not considered as part of the alternative set. This pattern of results is in line with the permissive account of alternative sets (Rooth 1985, 1992). In particular, the data suggest that unrelated items are part of the alternative set if and only if they are a possible replacement of a focused expression. The crucial aspect is that these unrelated items were not part of the same semantic network as the focused expression and they were not related to or mentioned in the context either. The permissive view assumes that items from different taxonomic categories can be considered as part of an alternative set. On the restrictive view, on the other hand, the unrelated items in these contexts might be excluded from consideration and there is no reason why these elements should be considered *per se*. In sum, the experiments favour a theory in which a formal set of alternatives contains various possible replacements instead of a theory where restriction applies locally/semantically. Note that I am not claiming all additonal possible alternatives are in the focus of attention of a listener. Rather, the observed effects arise because focus introduces/leads to encoding of a variable sensitive to alternatives, which match the focused expression.

Importantly, I do not dispute that the alternative set is restricted/limited in some way. However, the data suggest that listeners have access to a broader set of alternatives before all contextual factors that restrict this set have applied. In Rooth' terms, listeners seem to have access to the variable C before its domain of quantification is identified. What is more, the data show that the actual set of alternatives is determined during real time processing of the utterance. Byram-Washburn (2013) provides further evidence showing that listeners use contextual information to build the set of alternatives. More specifically, she found that items of different taxonomic category were primed if they were introduced together contextually. The point of the data presented here was to show that listeners consider additional alternatives to those that are enumerated contextually. It would, however, be unreasonable to assume that listeners consider the entire focus semantic value. Rather we see that they are considering what I refer to as a partially-restricted set – intermediate between the focus semantic value and the set of actual alternatives.

The finding that listeners consider additional alternatives to a contextually-enumerated set is consistent with the literature on homonym comprehension and the comprehension of negation and metaphors. In particular, this research indicates that even in a rich context that biases a particular meaning of an expression, inappropriate meanings of that expression receive some amount of activation (e.g., Swinney, Onifer, Prather & Hirshkowitz 1979; Gernsbacher & Faust 1991 and see Giora 2012 for an overview on metaphors). Similarly, in the comprehension of negation listeners first represent the affirmative proposition followed by the negated one in a subsequent step (e.g., Kaup & Zwaan 2003). What might be the reason that listeners consider a broader set of alternatives to focused expressions? First of all, this might be a consequence of the way our cognitive system is organized and it seems that the construction of alternative sets relies in part on general cognitive mechanisms such as spreading activation (see Gotzner 2015 and Husband & Ferreira 2015). Second, certain alternatives are retained in memory (as shown in

Fraundorf et al. 2010, 2013 and Spalek et al. 2014), possibly to serve communicative goals (see especially Giora 2012 fro such an account). In line with this assumption, studies by Kaiser (2010) indicate that participants are more likely to mention an alternative to a contrastively-focused expression later in the discourse.

To make a strong claim about the restrictive view proposed by Wagner (2006), it would be important to set up an experiment with the specific examples discussed by Wagner, comparing target items that are either mutually exclusive adjectives or not. The data presented here are more consistent with a permissive view of alternative sets but they cannot rule out this specific account. It is also important to note that ultimately focus particles like *only* quantify over the contextually-restricted set of alternatives. That is, a sentence with *only* excludes a small set of relevant alternatives, otherwise such sentences could never be appropriate (see Umbach 2001; Rooth 1992). The effect of *only* in the analysis presented here was not specific to possible replacements of a focused expression which was possibly due to the low number of observations. Gotzner (2015) provides additional evidence that focus particles interfere with the retrieval of unmentioned alternatives but not with general associates of a focused expression, indicating that some restrictions have already applied (see the next section for further discussion).

There is also one important caveat to the argument about possible replacements presented here. The distinction between possible replacements and non-replacements I and previous studies made was not purely based on syntactic considerations or semantic type match (as suggested by the Roothian framework). In many examples, possible replacements were determined by selectional restrictions of the verb and often some amount of world knowledge was involved. Nevertheless the results presented here suggest that this intuitive notion of possible replacements is a crucial factor in the establishment of alternative sets. It remains to be specified which exact factors restrict the set of alternatives, which I will turn to in the next section. The main point made here is that listeners do not only consider the small set of relevant alternatives but rather a partially-restricted set – an intermediate representation between the focus semantic value and the relevant alternatives.

4. Factors influencing the restriction of the alternative set

We have seen that listeners have access to a broader set of alternatives rather than only the small set of relevant alternatives. Now, we would like to know which factors influence the restriction of the domain of quantification of the set of alternatives.

In Rooth (1992), the restriction of alternatives is entirely left open to pragmatics and not further spelled out, which has been critized by Umbach (2001) and Cohen (1999). Umbach (2001) shows that anaphoric relationships play an important role in the restriction of alternative sets and therefore concludes that the selection of alternatives is a discourse-related phenomenon. Cohen (1999) argues that the Roothian view does not allow for a compositional computation of alternatives of complex sentences. He develops an account of alternatives based on

presupposition and discusses a variety of constraints on alternatives such as the selectional restrictions of the verb phrase (see also Blok & Eberle 1999). In a similar vein, Wagner (2012) shows that the head noun determines the alternatives to an adjective. For example, {*used*, *new*} may be appropriate alternatives if the head noun is *bicycle* but not when it is *boyfriend*.

The dissertation by Kim (2012) provides experimental evidence for a variety of factors that influence the restriction of alternative sets (see also Kim 2015). She employed a visual world paradigm to find out how the online interpretation of focus operators unfolds over time and how it interacts with the preceding context. In Experiment 1, participants were presented with auditory discourses that either contained the particle *only* or not (e.g., *Mark has some candy and apples. Jane only/ has some [oranges]*$_F$). Kim found that participants were faster at disambiguating the focused element (a picture of oranges) from a phonological competitor (a picture of oars) when the discourses contained the particle *only*. This finding indicates that participants were using the semantic alternative mentioned in the context sentences (*apples*) to predict the upcoming focused element when they encountered *only*. In another experiment, Kim (2012) compared the lexical contributions of the particles *only* and *also* in contexts where the focused element was either mentioned in the first sentence or novel (but of the same semantic category). The eyegaze patterns showed that *only* and *also* elicit different expectations concerning the upcoming referents: Whereas participants were more likely to fixate a subset member of a semantic category (e.g., *apples* from the category fruit) in the case of *only*, they were more likely to fixate the superset of a category (a picture with different kinds of fruit) in the case of *also*. Kim attributes these findings to the meaning differences among the two groups of particles. She concludes that listeners keep track of the discourse status of an entity (old/new) and use this information to identify the alternatives required to interpret upcoming focused expressions.

In another set of experiments, Kim explores the impact of world knowledge, comparing situations that vary in informativity. She shows that in a narrow context (e.g., *a newsstand*) participants are better at predicting the focused element (*magazines*) compared to a wider context (*drugstore*). A study by Fraundorf et al. (2013) provides further evidence concerning the impact of world knowledge on the consideration of alternatives. They investigated the impact of font emphasis on memory encoding of alternatives with varying degrees of plausibility and found effects of font emphasis on plausible alternatives (e.g., *British scientists* as an alternative to *French scientisits*) but not on less plausable ones (e.g., *Martian scientists*) even though both were mentioned in the discourse. These findings suggest that the set of actual alternatives is constrained by considerations of plausibility and that listeners only encode a limited set of alternatives in their memory representation of a discourse.[7] Kim further shows that there is a locality bias in that listeners search for the antecedent of the presupposition of *also* in the closest discourse both in terms of recency and hierarchical structure.

[7] Byram-Washburn (2013) provides further evidence that listeners use contextual information to build the set of alternatives. More specifically, she found that items that were not of the same taxonomic category were primed if they were introduced together contextually (similar to the examples presented in (7)).

The experiments by Kim (2012) and Fraundorf et al. (2013) indicate that mentioned plausible alternatives are in the focus of attention of the listener. This is consistent with the finding from the study presented here in that the mentioned semantically-related alternatives always received the highest amount of activation. The results from these studies and my study complement each other. The studies by Kim and Fraundorf et al. show which factors restrict the actual set of alternatives whereas the present study showed that listeners consider additional alternatives to the contextually-restricted set. These additional alternatives are likely to decay in memory over the course of time such that listeners only remember the contextually-restricted set of alternatives (see Spalek et al. 2014 and Fraundorf et al. 2010). Gotzner (2015) presents additional evidence that focus particles do not quantify over elements that are generally-associated with the focused expression but cannot replace it (e.g., *apple* and *maggot*, see Chapter 5). In conjunction, these results suggest that listeners consider a broader set of alternatives (yet not an unlimited one) and that focus particles operate on the set of relevant alternatives.

5. Conclusions

The work presented here is in line with the distinction between a focus semantic value and a contextually-restricted set of alternatives proposed by Rooth (1992). It was found that listeners consider a broader set of possible replacements of a focused expression. They do, however, not consider the entire focus semantic value but rather a partially-restricted set of alternatives.

Recent psycholinguistic experiments have provided important insights into the establishment of alternative sets in online language processing. In particular, it seems that the construction of alternative sets relies on two mechanisms (i) the initial activation of a broader set of alternatives and (ii) the narrowing down to the set of actual alternatives by competition mechanisms (see especially Gotzner et al. accepted and Husband & Fereirra 2015). Further experiments show how a variety of contextual factors influence the contextual restriction of alternatives such as mention, recency, discourse structure (locality) and plausibility (Kim 2012, 2015; Fraundorf et al. 2013; Byram-Washburn 2013). I have looked at the derivation of alternatives from the opposite angle, investigating whether listeners consider additional alternatives. The findings show that at some point listeners have considered a broader set of alternatives, which is predicted by a Roothian type of account.

Overall, the studies show that alternative sets constitute an important cognitive unit. We also hope that the paradigm presented here will inspire the investigation of further theoretical questions concerning the composition of alternative sets and that this type of research will help to develop an algorithm that determines the contextual set of alternatives.

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