'Czech' the alternatives: A probe recognition study of focus and word order[1]

Radim LACINA — *University of Osnabrück*
Radek ŠIMÍK — *Charles University*
Nicole GOTZNER — *University of Osnabrück*

Abstract. Comprehenders have been found to activate, select, and represent plausible alternatives to focused elements when processing incoming sentences (see Gotzner & Spalek, 2019 for an overview). This is consistent with Rooth's (1992) theory of focus interpretation, which claims that the function of focus is to create an additional level of meaning consisting of a set of propositions derived by replacing the focused element with its contextually appropriate alternatives of the same semantic type. However, the psycholinguistic research on the processing of focus has mostly been done on a small sample of Germanic languages which mostly use prosody to mark focus. We tested whether the current results generalise to Czech, which can use word order to mark narrow focus. We report on a probe recognition study aiming to test whether Czech comprehenders represent alternatives to focused subjects. The results provide preliminary evidence in favour of this claim.

Keywords: focus, word order, Czech, comprehension, focus alternatives, probe recognition task

1. Introduction

1.1. Focus and semantic theory

Focus is said to be one of the chief ways in which speakers tailor the truth-conditional content of their utterances to their context. It is a part of information structure, the "packaging" that speakers apply to the literal meaning expressed (Chafe 1976). As a category within this structure, has been associated with the new or contrastive parts of utterances at least since the work of the Prague School (Sgall et al. 1973). An influential approach to focus claims that what the category essentially does is introduce alternative meanings into the discourse (Krifka 2008). This account pioneered by Rooth (1985) stipulates that this is done by means of focus creating a new level of interpretation in addition to the ordinary semantic value of a given sentence. This focus interpretation is said to be a set of propositions derived by means of a systematic replacement of the element in focus with its contextually appropriate alternatives of the same semantic type (Rooth 1992). Take the following example:

(1)   [Jane]$_{Focus}$ played the sonata.

In sentence (1), the subject *Jane* is focused. Suppose we are in a world in which there are four individuals—Jane, Mary, Sally, and Fido the dog. According to the alternative semantics

---

theory, the focus value of (1) would in this case be the set of propositions $\{\text{played}(x, \text{the sonata}) \mid x \in E\}$. Here, E is the set of individuals of the same semantic type as the meaning of *Jane*, namely e. It can be written out as $\{\text{Jane, Mary, Sally}\}$. Notice that while also of type e, Fido cannot be in set E, since it is not contextually appropriate within (1), being a dog unable to perform sonatas.

However, the alternatives-based approach is not the only one taken by theorists to explain focus. Another strain of thought sees focus essentially in terms of the *newness* of the information provided by the focused element (Halliday 1967; Jackendoff 1972; Sgall et al. 1986). Another approach that we will discuss further sees focus essentially as a means of *noise reduction* (Schmitz 2008; Stevens 2016; Stevens and Roberts 2019). The so-called noisy channel theories in general see language as in effect a solution to the problem of communicating information in a situation where some of it may be lost or misperceived, in other words—across a noisy channel (Shannon and Weaver 1949). Within the Rational Speech Act (RSA) framework (Goodman and Frank 2016; Franke and Jäger 2016), there has been an attempt at combining the noisy channel approach to language with theories that postulate alternatives as a crucial part of what it means for a constituent to be focused (Bergen and Goodman 2015). In essence, the RSA framework is a way to model pragmatic inferences as an iterative Bayesian succession of social reasoning between speakers and listeners. The way to account for focus then is the following. As its starting point, the proposal of Bergen and Goodman (2015) takes the fact that focus status is associated with prosodic prominence in languages such as English (Gussenhoven 1999; Selkirk 1995). According to the above mentioned noisy channel approaches, speakers choose to give a particular element prosodic prominence in order to lower the probability of misperception on the part of the hearer. The way alternatives get in is by means of pragmatic inference. The hearer reasons that the speaker must have put prosodic prominence on a particular element in order to increase the probability that the hearer would correctly identify that particular element and not confuse it for another. This behaviour makes sense for the speaker if the speaker believes that they are in a situation where mistaking the focused element for one of its alternatives would be detrimental. This situation is for instance when the speaker believes these other alternatives to be false. The hearer then assumes that exactly such a process occurs in the mind of the speaker. Consequently, the hearer can derive an inference about these alternatives, namely that the propositions derived by replacing the focused element with them are false. As we can see, we arrive at precisely the specification of Roothian (1985; 1992) theories.

1.2. The processing of focus and its alternatives

Within psycholinguistic research, focus has been studied for its many processing effects. Firstly, Sturt et al. (2004) claimed that comprehenders processed focused information more deeply than they did backgrounded information. Anaphor integration (Sanford et al. 2009; Klin et al. 2004), attachment placement (Carlson et al. 2009; Carlson and Potter 2021, 2022), or ellipsis (Carlson 2015) processing have all been shown to be influenced by focus.

Over the past decade, a multitude of studies have shown that the formal theory of Rooth (1992) can be applied to the real-time comprehension of focus (see Gotzner and Spalek 2019 for an overview). Specifically, it has been found that the hypothesised focus alternatives are in fact routinely activated, selected, and represented in the course of comprehension.

Research has shown that focus alternatives receive improved memory encoding (Fraundorf

et al. 2010; Norberg and Fraundorf 2021). But crucially for the current study, let us now turn to the investigation of immediate processing and the mechanisms enabling comprehenders to take advantage of focusing and to build the improved memory representations discussed above. Husband and Ferreira (2016), building on the pioneering work by Braun and Tagliapietra (2010), conducted two lexical decision experiments with English comprehenders aiming to answer the question of the time course of the activation of focus alternatives. They presented their participants with sentences such as the following:

(2)   The museum thrilled the *sculptor* when they called about his work.

Their sentences were auditorily presented and the critical prime word *sculptor* was pronounced either with a contrastive (L+H*) or non-constrastive prosody. Following either 0ms (in Experiment 1) or 750ms (in Experiment 2) relative to the prime word, the participants saw a probe word on the screen. This probe was either a plausible focus alternative that could replace the focused word *sculptor* in the given context of (2), for example *painter*, a merely semantically associated word without the ability to replace the focused one—*statue* or an unrelated word serving as the baseline (*register*). What the researchers found was that while both alternatives and merely associated probes were primed and therefore activated at the earlier SOA of 0ms; at 750ms, this activation was maintained for plausible focus alternatives only. This was interpreted as evidence for a selection process that first activates a slew of related items that it then sifts through to come up with a final contextually appropriate set of only those elements that could replace the focused word in a given sentence.

In addition to the lexical decision task, which is said to target the level of immediate activation in the lexical-semantic network (Meyer and Schvaneveldt 1971), the probe recognition task has also been used to investigate focus alternatives in comprehension. In the task, participants are asked to evaluate whether a given probe appeared in some previously presented stimulus. As opposed to lexical decision, this method has been argued to tap into the mental model of the discourse and its representations (Gernsbacher and Jescheniak 1995). Using this method, it has been found that focus sensitive particles cause interference in the recognition of contextually mentioned alternatives and the rejection of unmentioned ones Gotzner et al. (2016). This interference effect was also found to be specific to plausible alternatives only with semantic associates being unaffected by focus particles like *only* (Gotzner and Spalek 2017).

While most of the research using the probe recognition task included contextually given alternatives in their stimuli, Jördens et al. (2020) conducted a study with only single sentences presented and no mentioned alternatives. Their German participants were exposed to sentences such as these (here in translation):

(3)   The *farmer* has brought *straw* into the barn.

In their experiment, either the word *straw* (critical condition) or the word *farmer* received contrastive prosody. Then, either the word *cows* or the unrelated *lifts* was probed. In the case of the former, this was a plausible alternative when contrastive prosody was placed on *straw*. The word was merely associated when *farmer* received it, since it could not serve as the subject of the sentence. What they found was that the unrelated probe garnered the fastest responses, the condition where *cows* was playing the part of the merely associated word had the slowest rejections, and, crucially, that when the probe word was a plausible alternative, it patterned

between the two in terms of response times.

The work on the processing of focus alternatives has been plentiful in the past decade, however, there are gaps in the literature. The first is that most of the research has been conducted on a small sample of Germanic languages (English, Dutch, and German). While there have been studies examining focus comprehension in other languages, cross-linguistic validation of the current results remains limited. Yan and Calhoun (2019) showed that focus alternatives were facilitated in a lexical decision task in Mandarin Chinese. As far as the memory representation of alternatives cross-linguistic research is concerned, Tjuka et al. (2020) report that the recall of plausible alternatives was supported by focus prosody in Vietnamese while noting that this effect was only present for female speakers.

One consequence of the dominance of Germanic languages in the literature on focus processing is that there is a bias towards the prosodic marking focus. However, languages can also use syntactic means as their primary way of focus marking (Zimmermann and Onea 2011). There have only been a few studies examining focus alternative processing in languages that primarily use syntactic means to mark focus. Studying Hungarian, Káldi et al. (2021) also examined the memory representation of the focused element and of alternatives and provided evidence suggesting that the recall of the focused element was facilitated. This was in line with the previous literature. This was the case in immediate, but not in delayed retrieval. As for focus alternatives however, their probe recognition study provided only indirect evidence in favour of focus alternative activation. Their first experiment, which employed an SOA of 0ms, found marginally significant effects of increased activation for alternatives. In their second experiment, there were six blocks between the presentation of stimuli and of the probe. The results of this delayed memory task showed that focused sentences lowered accuracy for all types of probes. The authors interpret this to be a consequence of semantic interference caused by the focus activation, selection and representation process. As far as response times were concerned, the authors report no effects of probe type or sentence type. Overall, the study of Káldi et al. (2021) suggests that the research on the improved memory representation of alternatives can be extended to languages with syntactically marked focus. However, their results are largely inconclusive.

Calhoun et al. (2022) have recently published new data on focus alternatives in Samoan. This language is claimed to use primarily syntactic means for the marking of focus. Calhoun (2015) reports that in an elicitation study, Samoan speakers produced non-canonical word orders when they intended to narrowly focus objects. They fronted the object and added the 'o particle. She also notes that the initial sentential position is the default one for nuclear accent (L+H*), which has been associated with focus alternative effects in Germanic languages, as noted above (Husband and Ferreira 2016; Braun and Tagliapietra 2010). In their study, Calhoun et al. (2022) first conducted a probe recognition experiment based on the design of Gotzner et al. (2016). They found that mentioned alternatives to the object were correctly recognised more slowly when the object was narrowly focused by means of fronting and the 'o particle. However, it must be noted that this effect was only marginally significant. No effect was found for contextually unmentioned alternatives. Their second experiment was a delayed recognition task, which was used to test whether focusing by means of word order manipulations improved recall for alternatives in Samoan. While they found no effect of focus marking on the accuracy of the recognition of alternatives, their response time data showed that Samoan comprehenders were

faster to recognise mentioned alternatives when the object was focused. This research is the first piece of evidence suggesting that even in a language with mostly syntactic focus marking, focus alternatives are represented in online processing. However, no strong conclusions from the study of Calhoun et al. (2022) can be drawn given that the critical effects of interest were only reported to be marginally significant.

To our knowledge, no research has so far been conducted on the processing focus alternatives in Slavic languages. Given their features, studying focus processing in these languages would provide a needed addition to the literature. This is mainly due to the relationship between information structure and word order that is explored in the next section.

1.3. Focus in Czech

Let us move on to a discussion of how the information structure category of focus is realised in Czech. The language is a part of the Slavic branch of the Indo-European family and relies heavily on inflection (Short 1993). The language exhibits relatively free word order (Jasinskaja and Šimík forthcoming). While all possible combinations of subjects, verbs, and objects are allowed, these differ in their frequency. Siewierska and Uhlířová (1998) observe that in a corpus of over 6000 transitive sentences of Czech, the most dominant word order was SVO, which accounted for 63.1% of sentences. The next most frequent word order was OVS with 14.6% of the corpus. All the other possible word orders exhibited frequences of under 10%. However, not all of these word orders are felicitous in every context.

The study of Czech information structure goes all the way back to the Prague School of Linguistics (Mathesius 1936). Since then, it has been claimed that word order variation in the language is associated with different configurations of information structure (e.g. Mathesius, 1941; 1936; Firbas 1971, 1992; Sgall et al. 1986). Independently of the particular analytical framework, all researchers agree that elements in a Czech sentence are ordered sequentially from the most known and given elements to the new. This means that the final position in a sentence is associated with the newest and most unexpected element (from the point of the view of the hearer).

Given that in the hitherto-studied languages (such as English or German), prosody plays a crucial role in the marking of focus, we ought to ask what the relationship between it and information structure is in Czech. Daneš (1957; 1959) notes that in the language, there is a default position for sentential stress and that it is the final word of the sentence. At the same time, Czech requires stress to be placed within the focused constituent. Thus, it seems that there is a correspondence between where both focus and prosody fall–at the end of sentences.

This relationship between prosody and focus in Czech has been investigated by Šimík and his colleagues (Groeben et al. 2017; Šimík and Wierzba 2015, 2017). In their research, they ran several acceptability judgement experiments with native Czech speakers. Their participants were exposed to auditorily presented Czech sentences with varying word orders and prosodic structures. What they found was that both maintaining the canonical word order with moving the main sentential stress to, say, a focused subject and having a non-canonical word order with the subject in the last position which receives this stress by default was equally accepted by participants. The combination of non-canonical word orders and altered prosodic patterns however was judged to be less acceptable (unless it was the initial constituent that received

stress).

What this means is that while focus is primarily marked by prosody in Czech, the speakers of the language can "make use" of the relatively free word order allowed for by the grammar (Junghanns 2001). They can place the element they wish to focus into the final position in the sentence in order for it to receive prosodic prominence by virtue of being in the default position for sentential stress. The results of the aforementioned studies also show that this is an either-or choice for the speakers of Czech—sentences with non-canonical word orders that also had shifted prosody were judged to be highly unacceptable.

These features make Czech a good candidate to test whether word order alone in the absence of realised prosody can induce comprehenders to create a set of focus alternatives in real-time processing. For if a Czech comprehender encounters a marked non-canonical word order, they ought to assign it a particular information structure configuration, namely one where the last element in the sentence is narrowly focused. What this allows a researcher to do is to present written stimuli manipulating the ordering of constituents and thus, presumably, guide participants towards particular set-ups of information structure.

1.4. The current study

In the current study, we aim at testing whether the previous psycholinguistic findings on Germanic languages regarding the processing reality of focus alternatives can be extended to Czech, a typologically different language that uses word order to mark different focus structures.

Furthermore, we wish to put to test the proposed tight connection between focus effects and prosody. As discussed above, the approach to focus taken by proponents of the RSA framework places the function of focus squarely into the domain of prosodic prominence. The theory claims that it is due to this attempted noise reduction (the probability of erroneous perception on the part of the hearer) that the mechanism of social reasoning is based on. Alternatives are considered, because of the speaker who who chooses to accentuate a particular constituent. Consequently, we may argue that this approach predicts that focus alternative effects, such as those discussed in the above section, would only be present when prosodic prominence is actualised. The flip side would then be that should stimuli be written only and no overt prosody present, no focus alternative effects ought to be observed. In other words, alternatives and focus are inherently tied to the prosodic realisation of sentences.

Thus, our main research questions are as follows—do Czech comprehenders represent focus alternatives to focused words in online processing? Are changes in word order sufficient to induce these effects? And finally—is realised prosodic prominence a necessary condition for focus alternative effects?

To answer these questions, we ran a web-based probe recognition task experiment with native Czech comprehenders, which employed rapid serial visual presentation (RSVP) as its mode of stimuli display. In it, we presented participants with sentences exhibiting non-canonical word orders. These were either subject final or verb final. In this way, we can manipulate which constituent in our stimuli is narrowly focused. Next, participants were to react to three different types of probes, which were all nouns. Being interested in the question whether Czech comprehenders represent alternatives to focused subjects, we judged the contrast between gen-

uine plausible, albeit unmentioned, alternatives and merely associated words, which could not replace the focused element, crucial. We also included completely unrelated items in order to ascertain whether our comprehenders were processing the stimuli sentences fully and were affected by the semantic similarity of the probes at all.

We base our predictions on the study of Jördens et al. (2020), which is the closest to the design employed here. They also employed the probe recognition task with "out of the blue" sentences that were not preceded by any context containing mentioned alternatives (as in, for example, Gotzner et al. 2016). As discussed above, their findings show that plausible unmentioned alternatives are facilitated compared to merely associated words but that both of these types of probes are slower compared to unrelated words.

Let us now turn to the specification of our hypotheses. Based on the predictions of the Roothian-inspired (1992) processing approach, the research conducted on other languages, and the features of Czech described above, we hypothesise that Czech comprehenders represent focus alternatives to focused subjects when these are marked by means of word order only.

Therefore, under the hypothesis specified above, we predict that we ought to see a difference in the response times of correct rejections of probes between those that are plausible alternatives and merely associated words only in the condition where the subject is narrowly focused, i.e. where our alternative probes are actually concordant with the focused element in semantic type. When the subject is focused, the alternatives ought to be facilitated compared to merely associated words. When the verb is focused, no such difference ought to be observed. Given previous results, we also expect both types of associated probes to be rejected more slowly compared to unrelated words.

Here, we report a pre-registered (https://osf.io/tjw73) web-based probe recognition experiment with native Czech speakers. In it, our participants were tasked with responding to whether particular probes appeared in stimuli sentences presented in a word-by-word fashion (RSVP).

2. Probe recognition experiment

2.1. Method

2.1.1. Participants

Altogether, 180 Czech native speakers were recruited from a participant pool of the Institute of Czech Language and Theory of Communication at Charles University, Prague. They received course credit for their participation. There were 156 women, 21 men, 1 participant of other gender and 2 participants chose not to answer the gender question. The mean age of the participants was 22.51 (st.d. = 4.96).

2.1.2. Materials

We constructed Czech sentences with the intent to manipulate focus by means of word order. In order to narrowly focus the subject, we placed it last in the sentence. This was our critical condition—the Subject Focus condition. For our control condition—the Verb Focus condition, we placed the verb last, achieving narrow verbal focus. Each sentence started with a locative or a temporal phrase followed by a direct object. The following is an example item:

(4) Minulou sobotu   sonátu zahrál [houslista]$_{Focus}$.
     Last   Saturday sonata played violinist
     'Last Saturday, the [violinist]$_{Focus}$ played the sonata.'

(5) Minulou sobotu   sonátu houslista [zahrál]$_{Focus}$.
     Last   Saturday sonata violinist   played
     'Last Saturday, the violinist [played]$_{Focus}$ the sonata.'

Both the critical Subject Focus condition and the control Verb Focus condition exhibit non-canonical word order, OVS and OSV respectively. We avoided using the canonical order of SVO for our control condition in order to prevent a frequency-based confound. Since both of the used structures are marked and rather infrequent, we expected comprehenders to have equal difficulty with either type of sentence appearing without supporting context.

In addition to the sentences, each item consisted of three probes. The Probe Type manipulation had three levels—Subject-Alternative, Subject-Associated, and Unrelated. In the current example item, the Subject-Alternative probe was *klavírista* (*pianist*), the Subject-Associated probe *symfonie* (*symphony*), and the Unrelated probe *obrubník* (*street curb*). These probes were matched for lemma frequency in the Czech National Corpus and for letter length (Křen et al. 2015).

We also conducted a rating study, in which native speakers of Czech (N = 33) were first asked to rate the perceived level of association between the subject of each item (here *violinist*) and the three types of probes on a Likert scale. Then their task was to judge the grammaticality of our sentence stimuli in the second half of the experiment. This way, we ensured that the Subject-Alternative and Subject-Associated probes were equal with regards to their association to the subject noun thus eliminating the risk of confounding. The grammaticality part of the rating study was added in order to make sure both of our Focus Status conditions were equally natural and acceptable for our participants. More information on the rating study can be found on the OSF platform (link above).

2.1.3. Procedure

Participants were given a link to a website with the experiment. Upon arriving, they read a consent form and indicated their consent by means of checking a box. Next, they filled out a brief demographic questionnaire and were given instructions for the experiment. This was followed by practice items.

In the experiment proper, each trial consisted of a Czech sentence presented in the rapid serial visual presentation (RSVP) mode with each word appearing in the middle of the screen for 300ms followed by 100ms of a blank screen. After the final word of each sentence, a probe word written in capital letters appeared. The stimulus-onset asynchrony with which the probe was displayed was kept at 2000ms measured from the subject noun in the experimental items. Thus, in the Verb Focus condition, the probe was placed on the screen 1600ms after the last word, whilst in the Subject Focus condition 2000ms elapsed, since the subject was always the final word in this condition. The participants were instructed to indicate as quickly as possible using their keyboard whether the given probe was present anywhere in the preceding sentence. They were told to press "j" for YES and "k" for NO. There was no feedback given and participants were under no time-out pressure. Each participant was exposed to 30 experimental

items and 60 filler items. Each experimental item was followed by two filler ones. Latin Square design was used and the order of items was randomised. The answers participants gave ("YES" or "NO") together with the associated response times (RTs) were measured.

2.1.4. Analysis

Our analysis was pre-registered on the Open Science Framework website (https://osf.io/tjw73). We fit the RTs of correct rejections of the probes in experimental items to a mixed-effects linear model. The RT data were entered as the dependent variable after log-transforming. The following factors were entered as fixed effects: centered Trial Order, Focus Status (Verb Focus and Subject Focus), Probe Type (Subject-Alternative, Subject-Associated, and Unrelated), and the interaction of the latter two. Since the factor of Probe Type had three levels, it was specified using Helmert Coding. The first contrast was set between the Subject-Alternative and Subject-Associated combined and the Unrelated condition. The second contrast compared the Subject-Alternative and the Subject-Associated condition. The factor of Focus Status was sum coded. As for our random effects structure, we followed Barr et al. (2013) and fit the maximal model that converged. The random effects structure of the final model included random intercepts for both participants and items and random slopes for participants.

2.2. Results

Mean response time per condition together with their standard errors are shown in Figure 1. The mixed effect model predicting log-transformed response times of correct rejections showed a significant main effect of Focus Status—probes in the Subject Focus condition were rejected quicker compared to those in the Verb Focus condition. Furthermore, a statistically significant main effect contrasting Subject-Alternative and Subject-Associated probes pooled to Unrelated ones was discovered. Finally, there was a significant main effect of centred trial with a negative effect estimate, meaning that participants got faster in responding to probes as the experiment unfolded. Contrary to our predictions, the model did not reveal a statistically significant interaction in the contrast between Subject-Associated and Subject-Alternative probes and the Focus Status condition. The full results of the model for our fixed effects can be found in Table 2.2.

Fixed effects	Estimate	SE	df	t-value	p-value
(Intercept)	7.1000	0.0284	232.3	310.803	<0.001 ***
Trial	−0.0028	0.0004	5037.0	−6.757	<0.001 ***
Focus status (FS)	−0.0161	0.0037	432.7	−4.297	<0.001 ***
Alternative (Al) v. Associated (As)	−0.0085	0.0051	191.1	1.656	0.099
Al+As v. Unrelated (Un)	0.0267	0.0027	335.0	−10.042	<0.001 ***
Al v. As : FS	0.0062	0.0047	220.2	1.328	0.185
Al+As v. Un : FS	0.0033	0.0026	215.9	1.252	0.212

Table 1: Fixed effects of a linear mixed effects model predicting log-RTs (full dataset)—Focus Status (FS) coded as -1 for Verb-Focus and 1 for Subject-Focus; Probe Type coded using Helmert contrasts, Subject-Alternative (Al), Subject-Associated (As) and Unrelated (Un)
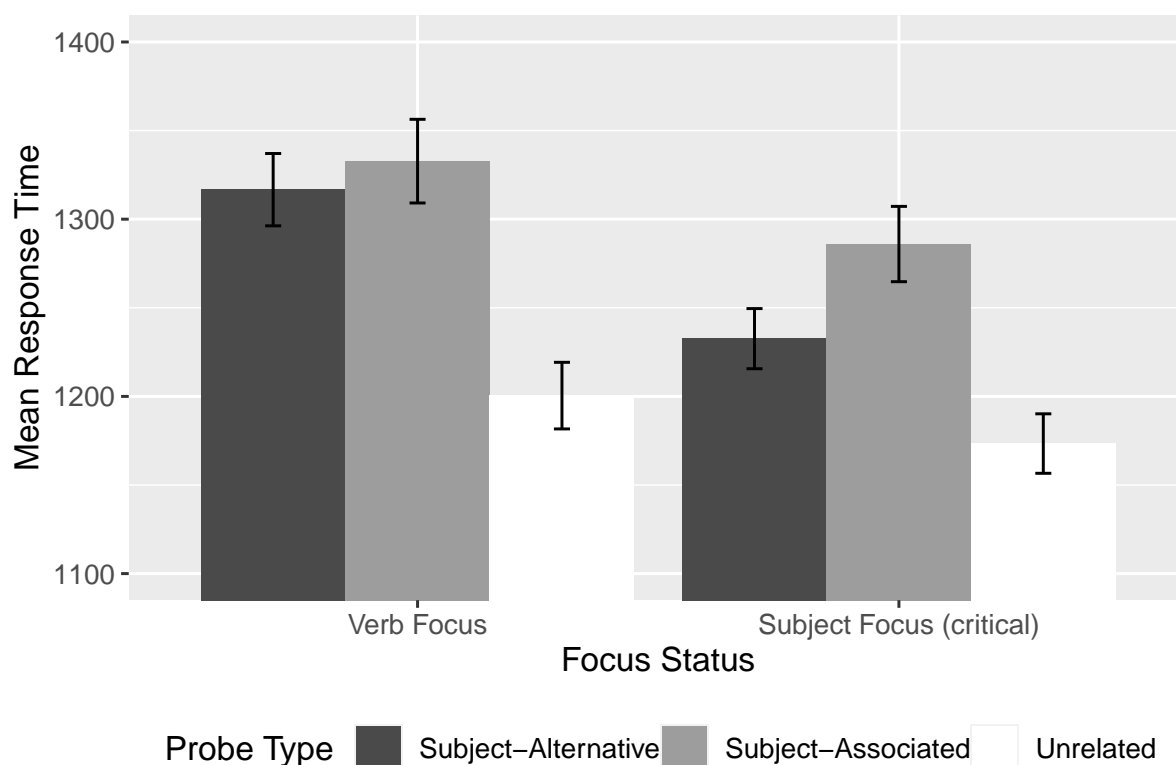
Figure 1: The means and SEMs of the trimmed RTs of correct rejections

3. Discussion

In the current study, we tested whether Czech comprehenders represent focus alternatives to subjects when their focus status is signalled through word order manipulations only. Our results remain inconclusive regarding this issue, since we did not find a significant interaction in the contrast between plausible alternatives to the subject and merely associated words and our word order manipulation of narrow focus on the subject noun or the finite verb respectively.

Our model showed us that there was a statistically significant difference between the two associated probe conditions and unrelated words, which were rejected faster. This is in line with our predictions set up based on the research of Jördens et al. (2020). The inhibition caused by semantic similarity of the associated probes with the subject in both conditions is evidence of our participants being influenced by our manipulations. It also suggests that they were paying attention to the content of the sentences presented to them.

Next, there is the observed main effect of Focus Status. The model shows us that probes in the Subject-Focus condition were rejected faster than those in the Verb-Focus one. This, we believe, could have two possible explanations. Firstly, there is the possibility of recency effects. Research has revealed that more recent information presented (e.g. presented closer to the point of probing) is privileged and is, for instance, better remembered (Bjork and Whitten 1974; Watkins et al. 1989). While we attempted to control for this by measuring our SOA from the point of the subject noun, which means that in the Verb-Focus condition, the probes appeared earlier after the last word of the sentence when compared to the Subject-Focus condition, it

remains plausible that the effect of having intervening material (the finite verb) caused enough interference to be detectable in the task. The second explanation lies in the relative frequency and acceptability of the two word orders used. As discussed in the introduction, Siewierska and Uhlířová (1998) note that in Czech, the OVS word order appears to be the second most frequent. This was the word order used in our Subject-Focus condition. Our control condition, on the other hand, used the OSV order, which is much less frequent. It is therefore possible that our comprehenders found it more difficult to process the sentences in the Verb-Focus condition and were therefore, on average, slower in their responses to probes in this condition. In fact, we had attempted to preempt this issue before we conducted the main study by having native Czech speakers rate the acceptability of our stimuli sentences (the details of this study can be found on our OSF project page). When our participants rated our original set of 40 experimental items, they did indeed consider the sentences in the Verb focus condition to be less acceptable than those with subjects in the final position. We manually excluded those sentence pairs (items) where the verb-final sentences were judged to be substantially less acceptable compared to their subject-final counterparts. The final set of the 30 items we selected was judged equally acceptable in both conditions however. This mitigates the above-mentioned concern.

While our pre-registered analysis did not confirm the visually present pattern of predicted results, further investigations into the data revealed possible reasons for this. As can be seen in Figure 2, which shows our data divided into two halves by trial order for each participant, the predicted facilitation in the Subject-Focus condition is strongly present and one can see no difference between the two associated conditions in the Verb-Focus condition in the first half of trials. On the other hand, the pattern disappears in the second half. This suggests that, perhaps, our participants became accustomed to our stimuli or employed different strategies in the course of the experiments.

We conducted a post-hoc sub-set analysis that included only the data from each of the participant's first half of trials. The fixed effects estimates together with the accompanying p-values can be seen in Table 2. The interaction of interest, i.e. the contrast between Subject-Associated and Subject-Alternative probes interacting with the Focus Status condition, is significant in this analysis. This confirms the pattern seen in Figure 2.

Fixed effects	Estimate	SE	df	t-value	p-value	
(Intercept)	7.1140	0.0244	256.5	291.905	<0.001	***
Trial	−0.0045	0.0012	2413	−3.876	<0.001	***
Focus status (FS)	−0.0204	0.0054	249.2	−3.796	<0.001	***
Alternative (Al) v. Associated (As)	−0.0019	0.0070	179.5	−0.269	0.788	
Al+As v. Unrelated (Un)	−0.0260	0.0037	305.7	−6.934	<0.001	***
Al v. As : FS	−0.0152	0.0068	178.1	−2.235	0.027	*
Al+As v. Un : FS	−0.0021	0.0037	467.6	−0.567	0.571	

Table 2: Fixed effects of a linear mixed effects model predicting log-RTs (block 1 only)—Focus Status (FS) coded as -1 for Verb-Focus and 1 for Subject-Focus; Probe Type coded using Helmert contrasts, Subject-Alternative (Al), Subject-Associated (As) and Unrelated (Un)

As for the explanations for the observed pattern of changes across the course of the experiment, we propose that the composition of the filler items used could be the reason. All of the probe
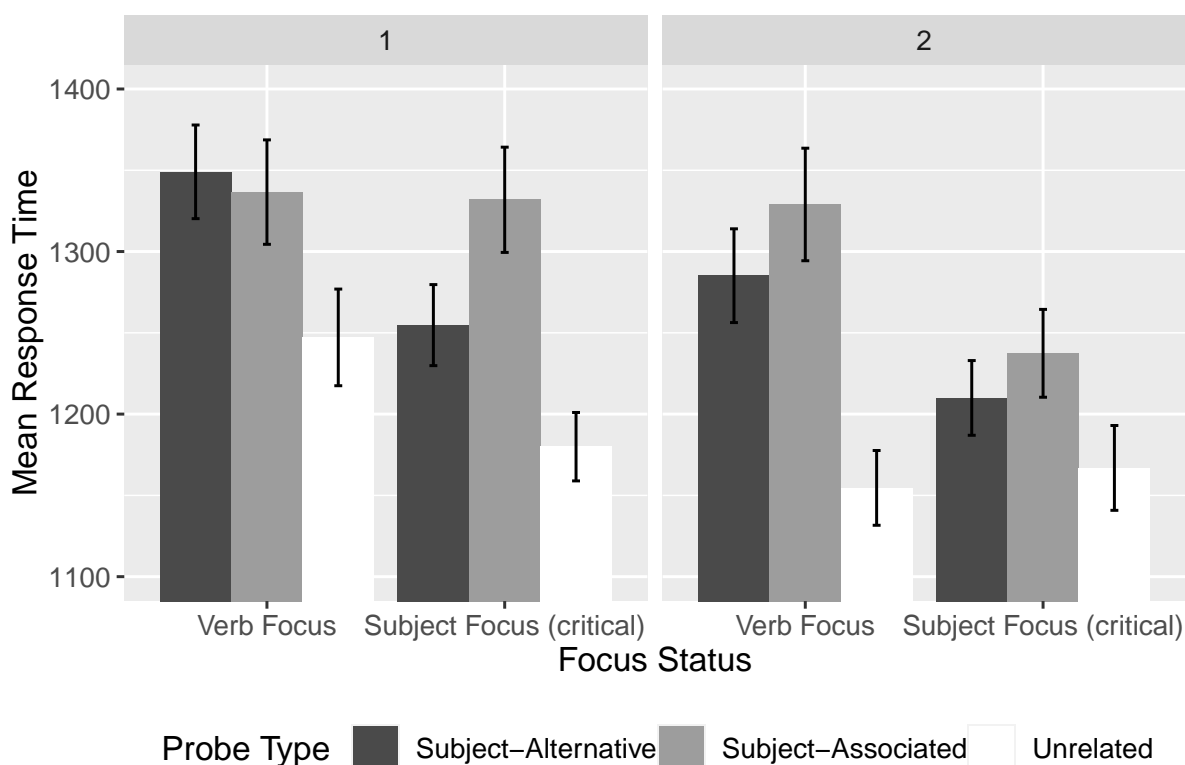
Figure 2: The means and SEMs of the trimmed RTs of correct rejections by block

words that participants were asked to respond to were in fact nouns. While we made sure the fillers employed were of varied structures and the probes to which participants were supposed to answer "yes" to were placed in different positions within the sentences presented, it remains plausible that given the fact that they were all nouns, our participants recognised this fact early on during the experimental session and learnt that in order to successfully complete the task, they did not in fact need to pay attention to any other word classes present in the sentences beside nouns.

This post-hoc analysis shows us that in the first half of trials, the predicted pattern holds. We observe the interaction in the difference between Subject-Alternative and Subject-Associated probes and the Focus Status manipulation. We argue here that this constitutes *preliminary evidence* in favour of the hypothesis that Czech comprehenders represent alternatives to focused subjects in cases where this element's focus status is marked purely by means of word order. Yet it must be stressed that while the pattern observed in the first half of trials and confirmed by the subset analysis is in line with our predictions and previous literature, it is suggestive only given that this analysis is exploratory in nature.

Taking the preliminary nature of this evidence into account, we can nevertheless say that the current study suggests that the previous results on the representation of focus alternatives have been replicated in Czech, a language which can use both prosody and word order to mark focus. It has been tentatively shown that Czech comprehenders are sensitive to changes in word order and treat the last position in sentences presented textually as conveying narrow focus. These

comprehenders then seem to build representations of unmentioned alternatives that could plausibly replace the focused subject in the given context. They treat these alternatives differently to merely associated nouns that are not potential alternatives in the given context.

The implications of the fact that we only observed the predicted pattern in the first half of the experimental session ought also to be discussed. Firstly, it suggests that focus alternative effects can change depending on the amount of stimuli of similar structure presented. That the expected facilitation effects for alternatives can wane in later trials points to factors such as extra-linguistic factors such as attention or conscious task strategies of participants playing a role in modulating these effects. What this suggests is that the activation, selection, and eventual representation of alternatives may not be an automatic mandatory process within parsing as imagined for example by Fodor (1983). This would be in line with viewing focus and its function as essentially pragmatic in nature. Even when recognising focus marking, comprehenders could choose not to engage in the process of activating, selecting, and representing alternatives should the context of the utterance render this process moot in purpose.

With regards to the question of the necessity of realised prosody, which, arguably, is predicted by a narrow interpretation of RSA models based on noisy channel approaches, our study remains largely inconclusive. If prosodic realisation were necessary, we ought to have seen no differences between Subject-Alternative and Subject-Associated probes conditional upon the Focus Status manipulation. That we found no significant interaction in our pre-registered analysis is consistent with this prediction. This is, of course, interpreting a null result and therefore, it cannot be argued strongly that no difference was present. Additionally, our post-hoc analysis suggests that Czech comprehenders do in fact activate and represent alternatives to focused subjects even when they have no realised prosody aiding them in the marking of focus. One counterargument to this might be that our comprehenders engaged in implicit prosody (Fodor 2002). Further research contrasting written stimuli and auditory stimuli should be conducted to shed further light on the relative role of prosody (be it explicit or implicit) and word order in focus comprehension in Czech.

4. Conclusion

In the current research, we attempted to generalise previous results regarding the activation and representation of focus alternatives in real-time comprehension that have been attained in Germanic languages, which mostly use prosody to mark focus, to Czech, a language that can use word order to manipulate information structure. The results of our probe recognition experiment suggest give us preliminary evidence that Czech comprehenders do indeed represent focus alternatives to subjects, whose focus status was conferred by word order only. However, given that only a post-hoc analysis of the first block of trials supports this, our conclusion can only be tentative until more data is collected and the pattern replicated on a larger sample.

References

Barr, D. J., R. Levy, C. Scheepers, and H. J. Tily (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language 68*(3), 255–278.

Bergen, L. and N. D. Goodman (2015). The strategic use of noise in pragmatic reasoning. *Topics in cognitive science 7*(2), 336–350.

Bjork, R. A. and W. B. Whitten (1974). Recency-sensitive retrieval processes in long-term free recall. *Cognitive Psychology 6*(2), 173–189.

Braun, B. and L. Tagliapietra (2010). The role of contrastive intonation contours in the retrieval of contextual alternatives. *Language and Cognitive Processes 25*(7-9), 1024–1043.

Calhoun, S. (2015). The interaction of prosody and syntax in Samoan focus marking. *Lingua 165*, 205–229.

Calhoun, S., M. Yan, H. Salanoa, F. Taupi, and E. K. Va'ai (2022). Focus effects on immediate and delayed recognition of referents in Samoan. *Language and Speech 66*(1), 175–201.

Carlson, K. (2015). Clefting, parallelism, and focus in ellipsis sentences. In *Explicit and Implicit Prosody in Sentence Processing*, pp. 63–83. Springer.

Carlson, K., M. W. Dickey, L. Frazier, and C. Clifton Jr (2009). Information structure expectations in sentence comprehension. *Quarterly Journal of Experimental Psychology 62*(1), 114–139.

Carlson, K. and D. Potter (2021). How focus particles and accents affect attachment. *Glossa: a journal of general linguistics 6*(1), 100.

Carlson, K. and D. Potter (2022). Focus attracts attachment. *Language and Speech 65*(2), 491–512.

Chafe, W. L. (1976). Givenness, contrastiveness, definiteness, subjects, topics and points of view. In C. N. Li (Ed.), *Subject and Topic*, pp. 25–55. New York: Academic Press.

Daneš, F. (1957). *Intonace a věta ve spisovné češtině*. Prague, Czechoslovakia: ČSAV.

Daneš, F. (1959). K otázce pořádku slov v slovanských jazycích. *Slovo a slovesnost 20*(1), 1–10.

Firbas, J. (1971). On the concept of communicative dynamism in the theory of functional sentence perspective. *Brno Studies in English 7*, 12–47.

Firbas, J. (1992). *Functional sentence perspective in written and spoken communication*. Cambridge: Cambridge University Press.

Fodor, J. A. (1983). *Modularity of mind: An essay on faculty psychology*. Cambridge, MA: MIT Press.

Fodor, J. D. (2002). Prosodic disambiguation in silent reading. In M. Hirotani (Ed.), *NELS 32: Proceedings of the 32nd Annual Meeting of the North East Linguistic Society*, Amherst, MA, pp. 112–132. GLSA Publications.

Franke, M. and G. Jäger (2016). Probabilistic pragmatics, or why Bayes' rule is probably important for pragmatics. *Zeitschrift für Sprachwissenschaft 35*(1), 3–44.

Fraundorf, S. H., D. G. Watson, and A. S. Benjamin (2010). Recognition memory reveals just how CONTRASTIVE contrastive accenting really is. *Journal of Memory and Language 63*(3), 367–386.

Gernsbacher, M. A. and J. D. Jescheniak (1995). Cataphoric devices in spoken discourse. *Cognitive Psychology 29*(1), 24–58.

Goodman, N. D. and M. C. Frank (2016). Pragmatic language interpretation as probabilistic inference. *Trends in Cognitive Sciences 20*(11), 818–829.

Gotzner, N. and K. Spalek (2017). Role of contrastive and noncontrastive associates in the interpretation of focus particles. *Discourse Processes 54*(8), 638–654.

Gotzner, N. and K. Spalek (2019). The life and times of focus alternatives: Tracing the activation of alternatives to a focused constituent in language comprehension. *Language and Linguistics Compass 13*(2), e12310.

Gotzner, N., I. Wartenburger, and K. Spalek (2016). The impact of focus particles on the recognition and rejection of contrastive alternatives. *Language and Cognition 8*(1), 59–95.

Groeben, L., R. Šimík, and F. Kügler (2017). Stress shift, focus, and givenness in Czech. In Y. Oseki, M. Esipova, and S. Harves (Eds.), *Formal Approaches to Slavic Linguistics 24: The New York University Meeting 2015*, Ann Arbor, MI, pp. 180–199. Michigan Slavic Publications.

Gussenhoven, C. (1999). Discreteness and gradience in intonational contrasts. *Language and speech 42*(2-3), 283–305.

Halliday, M. A. K. (1967). *Intonation and grammar in British English*. The Hague: Mouton.

Husband, E. M. and F. Ferreira (2016). The role of selection in the comprehension of focus alternatives. *Language, Cognition and Neuroscience 31*(2), 217–235.

Jackendoff, R. (1972). *Semantic interpretation in generative grammar*. Cambridge, MA: MIT Press.

Jasinskaja, K. and R. Šimík (forthcoming). Slavonic free word order. In J. Fellerer and N. Bermel (Eds.), *The Oxford guide to the Slavonic languages*. Oxford: Oxford University Press.

Junghanns, U. (2001). On rightward backgrounding. In U. Junghanns, G. Zybatow, G. Mehlhorn, and L. Szucsich (Eds.), *Current Issues in Formal Slavic Linguistics*, Frankfurt am Main, pp. 329–343. Peter Lang.

Jördens, K., N. Gotzner, and K. Spalek (2020). The role of non-categorical relations in establishing focus alternative sets. *Language and Cognition 12*(4), 729–754.

Káldi, T., Á. Szöllösi, and A. Babarczy (2021). Hungarian structural focus: Accessibility to focused elements and their alternatives in working memory and delayed recognition memory. *Frontiers in Psychology 12*, 514886.

Klin, C. M., K. M. Weingartner, A. E. Guzmán, and W. H. Levine (2004). Readers' sensitivity to linguistic cues in narratives: How salience influences anaphor resolution. *Memory & cognition 32*(3), 511–522.

Křen, M., V. Cvrček, T. Čapka, A. Čermáková, M. Hnátková, L. Chlumská, D. Kováříková, T. Jelínek, V. Petkevič, P. Procházka, et al. (2015). *SYN2015: representative corpus of written Czech*. Prague: Faculty of Arts, Institute of the Czech National Corpus, Charles University.

Krifka, M. (2008). Basic notions of information structure. *Acta Linguistica Hungarica 55*(3-4), 243–276.

Mathesius, V. (1936). Pokus o teorii strukturální mluvnice. *Slovo a slovesnost 2*, 47–54.

Mathesius, V. (1941). Základní funkce pořádku slov v češtině. *Slovo a slovesnost 7*(4), 169–180.

Meyer, D. E. and R. W. Schvaneveldt (1971). Facilitation in recognizing pairs of words: evidence of a dependence between retrieval operations. *Journal of Experimental Psychology 90*(2), 227–234.

Norberg, K. A. and S. H. Fraundorf (2021). Memory benefits from contrastive focus truly require focus: evidence from clefts and connectives. *Language, Cognition and Neuroscience 36*(8), 1010–1037.

Rooth, M. (1985). *Association with focus*. Ph. D. thesis, University of Massachusetts, Amherst, MA.

Rooth, M. (1992). A theory of focus interpretation. *Natural Language Semantics 1*(1), 75–116.

Sanford, A. J., J. Price, and A. J. Sanford (2009). Enhancement and suppression effects resulting from information structuring in sentences. *Memory & Cognition 37*(6), 880–888.

Schmitz, H.-C. (2008). *Accentuation and interpretation*. New York: Palgrave MacMillan.

Selkirk, E. (1995). Sentence prosody: Intonation, stress, and phrasing. *The handbook of phonological theory 1*, 550–569.

Sgall, P., E. Hajičová, and E. Benešová (1973). *Topic, focus, and generative semantics*. Kronberg: Scriptor.

Sgall, P., E. Hajičová, and J. Panevová (1986). *The meaning of the sentence in its semantic and pragmatic aspects*. Springer Science & Business Media.

Shannon, C. E. and W. Weaver (1949). *The mathematical theory of communication*. Champaign: University of Illinois Press.

Short, D. (1993). Czech. In B. Comrie and G. G. Corbett (Eds.), *The Slavonic languages*, pp. 455–532. London / New York: Routledge.

Siewierska, A. and L. Uhlířová (1998). An overview of word order in Slavic languages. In A. Siewierska (Ed.), *Constituent order in the languages of Europe*, pp. 105–149. Berlin/New York: De Gruyter.

Šimík, R. and M. Wierzba (2015). The role of givenness, presupposition, and prosody in Czech word order: An experimental study. *Semantics and Pragmatics 8*(3), 1–103.

Šimík, R. and M. Wierzba (2017). Expression of information structure in West Slavic: Modeling the impact of prosodic and word-order factors. *Language 93*(3), 671–709.

Stevens, J. (2016). Focus games. *Linguistics and Philosophy 39*(5), 395–441.

Stevens, J. S. and G. Roberts (2019). Noise, economy, and the emergence of information structure in a laboratory language. *Cognitive Science 43*(2), e12717.

Sturt, P., A. J. Sanford, A. Stewart, and E. Dawydiak (2004). Linguistic focus and good-enough representations: An application of the change-detection paradigm. *Psychonomic Bulletin & Review 11*(5), 882–888.

Tjuka, A., H. T. T. Nguyen, and K. Spalek (2020). Foxes, deer, and hedgehogs: The recall of focus alternatives in Vietnamese. *Laboratory Phonology: Journal of the Association for Laboratory Phonology 11*(1), 16.

Watkins, M. J., I. Neath, and E. S. Sechler (1989). Recency effect in recall of a word list when an immediate memory task is performed after each word presentation. *The American Journal of Psychology 102*(2), 265–270.

Yan, M. and S. Calhoun (2019). Priming effects of focus in Mandarin Chinese. *Frontiers in Psychology 10*, 1985.

Zimmermann, M. and E. Onea (2011). Focus marking and focus interpretation. *Lingua 121*(11), 1651–1670.