General discussion and conclusions

4.1 Introduction

This PhD project focused on verbs – grammatical categories of tense and aspect and on one special verb class that was of particular interest to us: unaccusative verbs. Our experimental studies investigated these three concepts in Bosnian/Croatian/Serbian (BCS). We merged some of the most challenging ideas from theoretical linguistics concerning tense, aspect, and unaccusativity with unanswered questions from previous experimental studies to design three experiments that aimed to answer the following research questions:

1. Do native speakers recognize tense and aspect violations in BCS at the critical word?
2. What are the electrophysiological correlates of aspect violations?
3. What is the relationship between aspect and unaccusativity?

To answer these research questions, we conducted three experiments: a self-paced reading (SPR) experiment, an ERP experiment and a cross-modal lexical priming (CMLP) experiment. We elaborate on the findings of our experimental studies in the sections that follow.

4.2 Tense and aspect are intrinsically related, yet, tense and aspect violations show different processing patterns

Tense and aspect are complementary domains as they both provide information about the temporal course of an event (Quirk et al., 1985; Binnick, 1991; Smith, 1991; 1997; 2013). Essentially, this information is semantic in its nature: tense locates the event in time (present past, future), while aspect describes the internal temporal contours of the event (completed, ongoing, iterative) (Comrie, 1976; 1985). We investigated the processing of BCS tense and aspect violations in a self-paced reading experiment and the processing of aspect violations in a yet another study – an ERP experiment.

To investigate tense violations in BCS, we designed sentences in a way that the perfect periphrastic verb form with past time reference violated the future time frame that was set by the topicalized temporal lexical adverb. An example of such sentence is given in (1).

(1) *Sutra/Jučer je pedagog pozivao roditelje na razgovor. Tomorrow/Yesterday AUXPRES counselor invitePSTPFV parents on talk

"*Tomorrow/Yesterday the counselor was inviting parents to a meeting.'

We reasoned that the tense violation is clearly disambiguated at the second element of the perfect periphrastic verb form - the non-finite participle (the underlined verb in 1) which we thus considered the critical word. Then we tested whether native speakers detect those violations at the participle, which would be manifested by longer reading times at that critical word in an online SPR study.

The self-paced reading experiment showed that tense violations are not detected at the non-finite participle of the perfect periphrastic verb form. Tense violations did not cause prolonged reading times at that critical word. Prolonged reading times would be indicative of a processing difficulty that should normally arise when the parser encounters the form that cannot be integrated in the temporal frame of the overall sentence. Our results suggest that the first research question concerning tense should be answered negatively – tense violations are not detected at the critical word. In an ERP study using the same type of tense violations as our SPR study, Tokmačić and Popov (2019) did not observe a P600 at the critical word that would
indicate reanalysis and repair processes or any other ERP component that would suggest that native speakers process tense violations.

To investigate aspect violations in BCS, we designed the stimuli in a way that the perfective verb form violated the present time frame of the sentence that was set by a temporal lexical adverb or an adverbial phrase. An example of the type of aspect violations used in our study is given in (2).

(2) *Učitljive trenutno upišu ocjene u dnevnik.
   Teachers currently write grades in gradebook
   ‘Teachers currently write grades in the gradebook.’

We argued that the aspect violation is revealed already at the verb which we then considered a critical word (the underlined verb in 2). Then, we tested whether native speakers process that violation at the critical word which would result in longer reading times at that position.

The self-paced reading experiment showed that aspect violations are detected immediately at the verb, causing longer reading times on the verb in ungrammatical sentences compared grammatical sentences. Offline grammaticality judgment data further confirmed that the use of perfective verb forms in real present contexts is deemed as an unambiguous violation. Our results suggest that the first research question concerning aspect should be answered affirmatively – aspect violations are detected at the critical word.

The findings of the ERP experiment that investigated the electrophysiological correlates of aspect processing in BCS show that aspect violations in BCS evoke a P600 in the 600-800 and 800-1000 ms time windows. Despite the fact that aspect violations are semantically based (present time frame is violated by the perfective semantics of completion), in our study, they evoked a P600 and not an N400 which would have indicated the inability to integrate lexical or semantic information. The P600 reflects the structural repair and reanalysis processes that are triggered by the inability of the parser to integrate the incongruous aspectual form into the temporal frame of the sentence.

The question is why two intrinsically related concepts – tense and aspect – are processed differently in BCS? We argued that the processing differences relate to inherent features of the tense and aspect systems in BCS. The immediate effect of aspect violations (the detection in the SPR experiment, unambiguous rejection in the grammaticality judgment task and the P600 in the ERP experiment) occurred because of the saliency of aspect violations. That saliency is the result of the different distribution of imperfective and perfective aspect in the present time frame – the perfective cannot be used in the real present context.

The absence of online effects for tense violations – in our SPR experiment and the ERP experiment by Tokmačić and Popov (2019) – was suggested to be caused by the flexibility of the tense system of BCS: even though it is its canonical use, the past tense does not necessarily convey past time reference in all contexts. We argued that the parser may not have registered the perfect periphrastic form as a violation of the future time frame of the sentence because the perfect periphrastic form can also express future time reference in restricted contexts such as narratives. Hence the absence of an effect on reading times in the SPR experiment and no significant ERP effects in Tokmačić and Popov (2019). However, the analysis of the offline data (verification task, accuracy in grammaticality judgment task) in our SPR experiment and the ERP experiment by Tokmačić and Popov (2019) showed that participants were aware of the tense violations and rejected them as ungrammatical.

To explain this discrepancy between online and offline data in our study and in Tokmačić and Popov (2019), we argued that initially, the parser activates all meanings of the inflected verb, one of them being future in the past. After the sentence has been processed, only the relevant interpretation remained. In our SPR experiment on tense that was the canonical
one: the past tense expresses past time reference. Consequently, in its canonical interpretation, the perfect periphrastic verb form violated the future time frame of the sentence so the native speakers rejected the sentences as ungrammatical in the offline grammaticality judgment task that was performed after the sentence had been processed.

At this point, another important similarity should be noted – the one between BCS tense system and English aspectual system. Flecken et al. (2015) did not find any effect for aspect violations in English (expect an early negativity that cannot clearly be attributed to aspect violations). We suggest that the lack of a P600 for English aspect violations is due to the fact that English allows one aspectual meaning to be conveyed by different forms (perfective meaning can be conveyed by present perfect and simple past), and one form to convey different aspectual meanings (present perfect can express imperfective and perfective meanings). Therefore, this flexibility in English aspectual system and the above-described flexibility in the BCS tense system led to a relative tolerance of aspect violations in Flecken et al. (2015) and tense violations in our SPR experiment and the ERP study by Tokmačić and Popov (2019).

The general conclusion from our studies on BCS is that the less flexibility there is in a time reference system, the more salient violations are. Consequently, effects of violations are more prominent in experimental studies, such as our SPR and ERP studies on aspect.

4.3 There is an interplay between perfective aspect and unaccusativity

The third research question concerned the relation between aspect and unaccusativity. To investigate whether unaccusativity is syntactically encoded but also to investigate the interaction between unaccusativity and perfective aspect, we performed a cross-modal lexical priming experiment in BCS. In this experiment, participants listened to sentences with unaccusative and unergative verbs in imperfective and perfective aspect and at three positions in the sentence (after the subject, after the verb, and 750 ms after the verb) words related (film)
or unrelated (wood) to the subject (an actress) or pseudo-words were shown on the screen and participants were asked to perform a lexical decision task.

(3) Glumica 1 u crvenoj sukni ukrašenoj zlatnim nitima i ružičastim cvjetovima pala 2 niz stepenice dok je voditelj 3 dodjele Oskara čitao njenu biografiju.
(An actress 1 in a red skirt embroidered with golden threads and pink flowers fell 2 down the stairs while the host 3 of the Oscar ceremony was reading her biography.)

The CMLP data showed that the meaning of the theme subject is re-constructed at the gap position as demonstrated by faster reaction times to related probes than to unrelated probes at the gap position in sentences with perfective unaccusative verbs, but not in sentences with unergative verbs.

Moreover, CMLP data showed that imperfective unaccusative verb forms have the same subject activation patterns as unergative verbs. There was no difference in reaction times to related and unrelated probes at post-verbal positions in sentences with imperfective unaccusative verbs and unergative verbs, showing that there was no re-activation of the meaning of the subject noun after the verb in either imperfective unaccusative or unergative sentences. We concluded that these results suggest that there is no post-verbal gap in these sentence types. This provides a straightforward answer to our third research question (What is the relationship between aspect and unaccusativity?): there is an inextricable link between perfective aspect and unaccusativity.

Based on CMLP results and the literature (Aljović, 2000; Koring & Mak, 2010; Koring et al., 2012), we argued that imperfective unaccusative verbs forms have theme subjects (just like perfective unaccusatives), but these theme subjects are base generated in the external argument position. Imperfective unaccusative verbs forms and unergative verbs assign
different theta roles to their subjects (theme and agent), but their subjects are base-generated in the external argument position. Perfective unaccusative verb forms have the same thematic structure as imperfective unaccusative verbs forms (a theme argument), but they have a different syntactic structure.

After showing an inherent link between perfective aspect and unaccusativity, we related our results to a study on English unaccusatives by Friedmann et al. (2008). Friedmann et al. (2008) found re-activation of the meaning of the subject in sentences with unaccusative verbs, not at the position of the gap but 750 ms later. We suggest that this delay in re-activation of the meaning of the subject is attributed to differences between English and BCS. In English, most past forms can also function as adjectives (‘the closed door’; ‘the dried fruit’), which was not a plausible interpretation in our BCS sentences. This explains why in BCS, re-activation of the filler occurred without delay – at the gap.

The three studies we conducted provide important insights into the effect of ambiguity or its absence in sentence processing. We discuss that in the next section.

4.4 Lexical access of semantically ambiguous verb forms

In the midst of growing discussions on whether sentence context guides lexical access, Swinney (1979) showed that lexical access is an autonomous process independent of the semantic context while post-access decisions are dependent on sentence context. More specifically, for lexically ambiguous words, Swinney (1979) showed that all the meanings of the word are activated upon its encounter (even in biased contexts that strongly favor one interpretation over the other) and that three syllables away (approximately 750-1000 ms), the contextually relevant interpretation is selected.

The findings of our SPR experiment on tense processing suggest the same initial activation of all meanings, only in our case, of inflected verb forms. The SPR experiment showed that at point of the lexical verb, where the violation is clearly disambiguated, and even at the object noun following it, reading times were not indicative of a processing difficulty. We argued that all the meanings of the past tense form (the past meaning and the future-in-the-past meaning) were momentarily activated and that only later in the sentence the appropriate interpretation (the past meaning) was selected which is why tense violations were rejected in the end-of-sentence grammaticality judgment task. Essentially, what our SPR experiment shows is that initially, upon encountering the past tense form, lexical access is not directed by sentence context. The same explanation can account for the ERP findings of Tokmačić and Popov (2019) who observed the identical effect for tense violations in BCS – no indication of an ungrammaticality detection online but an unambiguous rejection of ungrammatical sentences offline, in a grammaticality judgment task.

Furthermore, Dragoy et al. (2012) report that the ERP data and reaction time data in their two studies suggest that violations by a past tense verb were detected with a delay and not at the point of the violation. They explain that native speakers initially coerce the interpretation of a past tense verb into an interpretation where it conveys present time reference (congruent with the temporal frame of the sentence) and only subsequently, that interpretation is rejected and the interpretation of a past tense verb expressing past time reference is selected.

Moreover, we suggested that Friedmann et al. (2008) found a delayed re-activation of the meaning of the subject for unaccusative verbs because English unaccusative past tense verb forms were ambiguous between the unaccusative reading and the adjectival reading. Our CMLP experiment did not find such delay because BCS unaccusative verb forms in our experiment did not pose such an ambiguity.

The findings in Friedmann et al. (2008), Dragoy et al. (2012), Tomačić and Popov (2019) and our SPR experiment are in line with Swinney’s (1979) findings on processing lexically ambiguous words. The same processing pattern can be claimed to hold for inflected
verb forms too – all the meanings are initially activated and later in the sentence, the relevant meaning is selected.

Therefore, the immensely important finding of Swinney (1979) on the independency of lexical access holds not only for lexical words such as nouns but also for inflected verb forms. When a verb form is used to convey more than one meaning, all the meanings are activated and subsequently, in the course of the sentence, the relevant interpretation is selected and other interpretations are discarded. This gives another perspective on what we claimed above – the more flexibility there is in a tense or aspect system, the less salient the violations are. More precisely, the BCS tense system shows considerable flexibility as one form (e.g., the past tense form) can be used to convey the past, but also the present and the future time meaning. The lesser degree of saliency of those violations in BCS is only a consequence of the fact that upon encountering the past tense verb form, all the meanings are initially accessed and only the relevant one is selected in the course of the sentence.

4.5 Limitations and suggestions for future research

The SPR study on tense and aspect processing and the ERP study on aspect processing are first such studies in BCS. Both studies provided insights into online processing of temporal violations caused by the time reference of the verb form or aspect feature on the verb form.

What our SPR and ERP studies could not disentangle concerning tense processing is the secondary use of tense versus the ungrammatical use of tense. We argued that tense violations were not processed at the critical word because the parser did not detect them as violations as periphrastic verb forms that violate the future time frame of the sentence can actually express future time reference in restricted contexts. Further studies could investigate methodological efforts to create unambiguous tense violations.

Our SPR and ERP experiments show that aspect violations are detected without delay and that aspect violations yield a robust P600, as in Russian (Zeller and Clasmeier, 2020). However, we did not tap into aspectual pairs where the aspectual morphology introduces a new semantic dimension to the verb’s meaning (pisati – prepisati: ‘to be writing’ – ‘to have copied’). We explained that in the literature such aspectual morphology is treated as derivational (e.g., Bybee, 1985; Dahl, 1985). Future studies can address such aspect violations to investigate whether aspect can also involve processing at the lexical-semantic level which would be reflected in the N400 effect for aspect violations.

The CMLP experiment we conducted is the first experimental study on unaccusativity and its interaction with verbal aspect in any language. The study provided insights into processing of sentences with unergative verbs, perfective unaccusative verb forms, and imperfective unaccusative verb forms. The limitation of the study is that only one class of unaccusative verbs was investigated: non-alternating unaccusatives. For future research, it is interesting to investigate verbs with alternating unaccusativity, those that we refer to as anticausatives (She broke the glass – The glass broke). In addition to raising of the theme from the underlying object position to the subject position, BCS anticausative verbs involve an additional lexical operation – insertion of the particle ‘se’. If we assume that the transitive counterpart of anticausative verbs is the one stored in the lexicon and that the anticausative variant is derived by a lexical operation, some proposals assume that the particle ‘se’ is inserted after the agent is eliminated from the transitive counterpart most likely to absorb case (e.g., Franks, 1995). A lexical operation of agent removal and inserting the morpheme 'se’ in addition to movement of the internal argument to the external argument position means that in BCS, anticausatives are syntactically more complex than non-alternating unaccusatives. Future studies could address the time course of processing anticausative verbs.