

An ERP Study on Aspectual Mismatches in Converbial Contexts in Polish*

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Abstract

In an experiment using event-related brain potentials (ERPs), we investigated morphological and semantic/pragmatic mismatches in converbial contexts in Polish, a language with overt aspectual morphology. The morphological mismatches were caused by violations of selectional restrictions imposed by anteriority and simultaneity converbial morphemes on their verbal stems. Simultaneity converbial morphemes combined with a wrong perfective verbal stem elicited a P600 component, whereas anteriority converbial morphemes combined with a wrong imperfective verbal stem elicited a combined N400 + a weak P600. The N400 component found for ungrammatical anterior converbs is interpreted as resulting from anterior converbs being less frequent. We attributed the difference in the strength of the P600 component in these two morphological conditions to the fact that the morpho-syntactic violations are attenuated when a given form is less frequent and hence its lexically encoded grammatical constraints responsible for a given violation are more difficult to retrieve from the lexicon. The semantic/pragmatic mismatches resulted from not respecting the temporal ordering requirements imposed by simultaneous and anterior converbs. The question was whether imperfective aspect as being semantically less marked than its perfective counterpart is prone to tacit repair mechanisms. In our experiment we find a late positivity in the expected ‘inceptive coercion’ case and we treat it as a signature reflecting a binary decision – a competition between two forms: a congruous perfective form of the matrix predicate and an incongruous imperfective form. Additionally, we found evidence that creating an inclusion relation between two eventualities is more costly to process than creating an overlapping relation between two eventualities.

Keywords: *Converbs, Aspect in Polish, Morphological and pragmatic mismatches, ERPs*

1 Introduction

The goal of the paper is to report new psycholinguistic (*Event Related Potentials*, ERP) results related to the processing of grammatical aspect in converbial contexts in Polish. What is special about Polish converbs? Converbs (also referred to as conjunctive participles, gerunds, depending on the linguistic tradition) are temporally anchored participial clauses functioning in a sentence as optional (i.e., adjunct-like) adverbial modifiers. From the point of view of the temporal relations between the matrix and the embedded event two types of

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converbs can be distinguished: (i) simultaneous converbs (see (1a)) and (ii) anterior converbs (see (1b)).^{1, 2}

- (1) a. Anna szła do pokoju pal-ąc papierosa w pośpiechu.
 Ann walk.IMPF to room smoke.IMPF-SIM.PRT³ cigarette in hurry
 ‘Ann was going to the room (while) smoking a cigarette in a hurry.’
- b. Anna we-szła do pokoju za-pali-wszy papierosa w pośpiechu.
 Ann PERF-walk to room PERF-smoke-ANT.PRT cigarette in hurry
 ‘Ann entered the room (after) having smoked a cigarette in a hurry.’

Polish converbs impose two kinds of restrictions: (i) specific morphological selectional requirements as well as (ii) specific semantic/pragmatic constraints on temporal ordering.

1.1 Morphological Selectional Requirements

Facts A simultaneous converb like *paląc* in (1a), meaning ‘while smoking’, consists of a converbial morpheme *-ąc* attached to a verbal stem. An anterior converb like *zapaliwszy* in (1b), meaning ‘after having smoked’, consists of a converbial morpheme *-wszy* attached to a verbal stem. What is particularly relevant for our study is the fact that these two converbial morphemes impose specific selectional restrictions as to what kind of an aspectual verbal stem they can be combined with: the simultaneity morpheme *-ąc* selects for an imperfective verbal stem while the anteriority morpheme *-wszy* selects for a perfective verbal stem. Given that in Polish every verb is morphologically marked either by perfective or imperfective aspect, the question which we want to address in this paper is what happens in the brain when there is a mismatch between an overtly marked aspectual form and some other expression in a sentence selecting for the opposite aspectual value. More precisely, what happens in the brain when the simultaneity morpheme *-ąc* semantically selecting for an imperfective verbal stem is combined with a perfective verbal stem, as in (2a). Similarly, the question is what happens in the brain when the anteriority morpheme *-wszy* semantically selecting for a perfective verbal stem is combined with an imperfective verbal stem, as illustrated in (2b).

- (2) a. *Anna szła do pokoju za-pal-ąc papierosa w pośpiechu.
 Ann walk.IMPF to room PERF-smoke-SIM.PRT cigarette in hurry
 ‘*Ann was going to the room (while) having smoking a cigarette in a hurry.’
- b. *Anna we-szła do pokoju pali-wszy papierosa w pośpiechu.
 Ann PERF-walk to room smoke.IMPF-ANT.PRT cigarette in hurry
 ‘Ann entered the room (after) having smoking a cigarette in a hurry.’

Predictions We know from the literature that morpho-syntactic selection which is semantically based should engender a P600 component. The studies reported in Münte et al. (1997), Huddleston et al. (2003) and Yamada and Neville (2007) show that morpho-syntactic violations which lead to a P600 in real language sentences do not emerge or are attenuated if used in a jabbberwocky context. Bott (2010) takes this to mean that the P600 is an index of interpretation difficulty reflecting both semantic and syntactic integration problems.

¹ To be precise, there are also posterior converbs (as reported for the Panoan language Shipibo-Konibo; cf. Valenzuela 2005). These are, however, typologically quite rare.

² The following abbreviations will be used in the glosses: IMPF = imperfective, PERF = perfective, SIM.PRT = simultaneous converb, ANT.PRT = anterior converb.

³ For clarity, we will separate converbial morphemes as well as perfective prefixes from the rest of the verb with a hyphen, although this is not a convention of Polish orthography.

The P600 (sometimes in combination with a LAN) is also the component which is usually found in morpho-syntactic and semantic tense violation contexts (see, e.g., Allen et al. 2003, Steinhauer and Ullman 2002 and Baggio 2004). Importantly, no N400 has been found in these studies.

Another relevant study is that by Zhang and Zhang (2008) who report a biphasic 200-400 ms posterior and left central negativity and P600 pattern, instead of a LAN or N400, for agreement violations of Chinese grammatical aspect.

Given that in our present study on converbs in Polish we have aspectual errors and given that such aspectual morphological mismatches are also semantically based, at least three possible outcomes can be expected: *Prediction (i)* a P600, *Prediction (ii)* a LAN + P600, *Prediction (iii)* a biphasic 200-400 ms posterior and left central negativity and a P600. Moreover, whatever outcome is found, the initial hypothesis is that it will be the same for both morpho-syntactic violations: the simultaneity morpheme *-qc* combined with a perfective verbal stem and the anteriority morpheme *-wszy* combined with an imperfective verbal stem.

1.2 Semantic/Pragmatic Constraints on Temporal Ordering

Facts In addition to the fact that converbial morphemes impose specific morphological selectional restrictions, they also impose specific temporal orderings between the main clause eventuality and the converbial eventuality. Obviously, the anterior converb *zapaliwszy* ‘after having smoked’ in (1b) requires that the main clause eventuality follows the converbial eventuality, whereas the simultaneous converb *paląc* ‘while smoking’ in (1a) requires that there is an overlapping temporal relation between the main clause eventuality and the converbial eventuality. Ideally, the perfect match for an anterior converb would be a perfective matrix verb (just as in (1b)) while the perfect match for a simultaneous converb would be an imperfective matrix verb (just as in (1a)). This is so because a perfective denotes an eventuality with clear boundaries which in turn makes it possible to locate such a perfective eventuality after the converbial eventuality. In contrast, an imperfective verb denotes an unbounded eventuality which as such can overlap with the converbial eventuality. Now given this, another question we are interested in is what happens in the brain when these ideal matches are not respected, that is, when an anterior converb is combined with an imperfective matrix verb and a simultaneous converb is combined with a perfective matrix verb, as shown in (3a) and (3b) respectively.

- (3) a. ?Anna szła do pokoju za-pali-wszy papierosa w pośpiechu.
 Ann walk.IMPF to room PERF-smoke-ANT.PRT cigarette in hurry
 Lit.: ‘Ann was going to the room (while) having smoked a cigarette in a hurry.’
 Intended: ‘Ann started walking to the room after she had smoked a cigarette in a hurry.’
- b. ?Anna we-szła do pokoju paląc papierosa w pośpiechu.
 Ann PERF-walk to room smoke.IMPF-SIM.PRT cigarette in hurry
 ‘Ann entered the room while smoking a cigarette in a hurry.’

Predictions Given that neither in (3a) nor in (3b) such ideal matches are respected, we might expect that they will give rise to either some implicit repair process or at least increased processing costs or they will result in a violation. In order to “repair” (3a), the processor would need to add an initial boundary (beginning phase) to the main clause eventuality, thus making it possible to temporally locate it after the eventuality denoted by the anterior converb. Conversely, in order to interpret (3b), the processor would need to include the main clause eventuality in the converbial eventuality, thus satisfying the “simultaneity” temporal relation as required by the simultaneous converb. In the case of (3a) we might expect a kind

of additive (more precisely, inceptive) coercion which – as reported in the literature (see Bott 2010) – gives rise to a working memory LAN in German. On the other hand, given the fact that in Polish – in contrast with German – there is overt aspectual morphology which could be used to express inception, we might expect that it will block an implicit repair process (coercion) which in turn probably will give rise to a different ERP component than that one found for coercion (in German).

Regarding the situation in (3b), our initial hypothesis is that it will be more difficult to create an “inclusion” relation between the main clause and the converbial eventuality to satisfy the temporal ordering relation requirement imposed by the simultaneous converb, as opposed to a situation in which both main and converbial eventualities are perfectly overlapping, as in (1a). It will be interesting to see whether this expected increase in processing costs will be manifested in some specific ERP signature.

2 Design and Experimental Procedures

2.1 Design

The research questions discussed in sections 1.1. and 1.2 give rise to the following experimental design. Because we have two kinds of morphological mismatches, *perfective + *-qc_{SIM}* and *imperfective + *-wszy_{ANT}*, and two kinds of semantic/pragmatic mismatches, anterior converb + imperfective main verb and simultaneous converb + perfective main verb, we decided to create two sets of data, each set consisting of three conditions: Condition 1. *Control*, Condition 2. *Morphological mismatch*, and Condition 3. *Semantic/pragmatic mismatch*. In the first set (Set A) we only have imperfective main verbs, and in the second set (Set B) we only have perfective main verbs.

Table 1 Experimental design

Set	Main clause	Converbial clause	Condition
A	imperfective	✓simultaneous *simultaneous ✓anterior	1. Control 2. Morphological mismatch 3. Semantic/pragmatic mismatch
B	perfective	✓anterior *anterior ✓simultaneous	1. Control 2. Morphological mismatch 3. Semantic/pragmatic mismatch

Examples: Set A

Condition 1: Control

✓Anna szła do pokoju pal-ąc papierosa w pośpiechu.
Ann walk.IMPF to room smoke.IMPF-SIM.PRT cigarette in hurry
'Ann was going to the room (while) smoking a cigarette in a hurry.'

Condition 2: Morphological mismatch

*Anna szła do pokoju za-pal-ąc papierosa w pośpiechu.
Ann walk.IMPF to room PERF-smoke-SIM.PRT cigarette in hurry
'*Ann was going to the room (while) having smoking a cigarette in a hurry.'

Condition 3: Semantic/pragmatic mismatch

?Anna szła do pokoju za-pali-wszy papierosa w pośpiechu.
Ann walk.IMPF to room PERF-smoke-ANT.PRT cigarette in hurry
Lit.: 'Ann was going to the room (while) having smoked a cigarette in a hurry.'
Intended: 'Ann started walking to the room after she had smoked a cigarette in a hurry.'

Examples: Set B

Condition 1: Control

✓ Anna	we-szła	do pokoju	za-pali-wszy	papierosa	w pośpiechu.
Ann	PERF-walk	to room	PERF-smoke-ANT.PRT	cigarette	in hurry

‘Ann entered the room (after) having smoked a cigarette in a hurry.’

Condition 2: Morphological mismatch

*Anna	we-szła	do pokoju	pali-wszy	papierosa	w pośpiechu.
Ann	PERF-walk	to room	smoke.IMPF-ANT.PRT	cigarette	in hurry

‘Ann entered the room (after) having smoking a cigarette in a hurry.’

Condition 3: Semantic/pragmatic mismatch

?Anna	weszła	do pokoju	pałac	papierosa	w pośpiechu.
Ann	PERF-walk	to room	smoke-SIM.PRT	cigarette	in hurry

‘Ann entered the room while smoking a cigarette in a hurry.’

Condition 1 is a control condition since the simultaneous converb in Set A is derived from an imperfective (durative/unbounded) verb, thus obeying the selectional restrictions of the simultaneity morpheme *-qc*, and accordingly, the anterior converb in Set B is derived from a perfective (bounded) verb, thus obeying the selectional restrictions of the anteriority morpheme *-wszy*.

Condition 2 represents a morphological mismatch since in Set A the simultaneity morpheme *-qc* is combined with a perfective (bounded) verb hence its selectional restrictions are violated, and accordingly, in Set B the anteriority morpheme *-wszy* is combined with an imperfective (unbounded) verb.

Condition 3 is an instance of a semantic/pragmatic mismatch at the discourse level. In Set A the converbial clause contains an anterior converb which requires that the eventuality denoted by the main verb should be temporally located (hence it should begin) after the eventuality in the converbial clause. For this to happen, the eventuality in the main clause must have (at least) an initial boundary in order to be located after the eventuality in the converbial clause. As already mentioned, bounded eventualities in Polish are morphologically manifested by means of perfective aspect. However, the main verb in Condition 3/Set A is imperfective (i.e., semantically unbounded) hence there is a mismatch between the requirements of the anteriority morpheme and the unbounded interpretation of the main verb. In order to process and understand this sentence, there is a need for some repair of this mismatch. The unbounded eventuality in the main clause has to be reinterpreted as having a clear inception.

In Condition 3 in Set B the converbial clause contains a simultaneous converb which imposes a simultaneity interpretation, i.e., the eventuality denoted by the main verb should be temporally overlapping with the eventuality in the converbial clause. Ideally, an imperfective verb denoting an unbounded eventuality should be used in the main clause to guarantee the overlapping temporal relation between two events as required by the simultaneous converb. However, in this case a perfective verb is used in the main clause which – by denoting a bounded eventuality – cannot be simultaneous with the converbial eventuality, but is rather understood as enclosed within it. Therefore, as already pointed out in section 1.2, one might expect that it should be more difficult to create such a temporal connection between a durative eventuality denoted by a simultaneous converb and a bounded eventuality expressed by a perfective verb.

For “morphological mismatch” conditions we used a within-set comparison with the control condition. In other words, sentences in Condition 1/Set A served as a control for sentences in Condition 2/Set A, and accordingly, sentences in Condition 1/Set B served as a control for sentences in Condition 2/Set B.

Regarding the “semantic/pragmatic mismatches”, an across-set comparison was used. More precisely, the control condition for sentences in Condition 3/Set B were sentences in Condition 1/Set A. Accordingly, the control condition for sentences in Condition 3/Set A were sentences in Condition 1/Set B. Sentences in Condition 1/Set A served as a control condition for sentences in Condition 3/Set B because such sentences were identical except for the fact that in those in Condition 1/Set A imperfective main verbs were used. Likewise, sentences in Condition 1/Set B served as a control condition for sentences in Condition 3/Set A because such sentences were identical except for the fact that in those in Condition 1/Set B perfective main verbs were used. Table 2 summarizes the relevant comparisons between the conditions.

Table 2 Relevant comparisons

	Morphological mismatches
Comparison 1	<i>Condition 1/Set A (control) vs. Condition 2/Set A (morphological violation)</i>
Comparison 2	<i>Condition 1/Set B (control) vs. Condition 2/Set B (morphological violation)</i>
	Pragmatic mismatches
Comparison 3	<i>Condition 1/Set B (control) vs. Condition 3/Set A (“inception”)</i>
Comparison 4	<i>Condition 1/Set A (control) vs. Condition 3/Set B (“inclusion”)</i>

Material 300 stimulus items were constructed. All of them consisted of a main clause followed by a converbial clause. The structure of the main clauses was: subject, finite past tense verb followed by either an object or an adverbial. Converbial clauses consisted of the following sequence: a simultaneous or an anterior adverbial participle derived from a transitive verb, followed by a direct object and an adverbial. (The latter was included to prevent spill-over effects.)

Two stimulus lists were created using these 300 tested sentences. Each list containing 150 sentences (50 per Condition) was supplemented by 150 filler stimuli, of these 75 were well-formed and plausible, and 75 were ill-formed. The filler stimuli were complex sentences, i.e., similarly to tested sentences, they consisted of a finite main clause and an adverbial clause. The incorrect filler sentences mainly contained different kinds of aspectual mismatches. All the stimuli were pseudo-randomly ordered.

The critical word for us was the converb, but triggers were marked both on the critical word and the word following it. The length of the critical words (i.e., the converbs) was controlled for. This was important because of the peculiarities of Polish aspectual morphology. To keep the matters short, in Polish there are bare imperfectives (i.e., non-derived forms), e.g., *pisać_{impf}* ‘to write’ and secondary imperfectives, e.g., *[[podpis_{perf}]+ywać]_{impf}* ‘to sign’. Because secondary imperfectives contain the imperfectivizing suffix -ywa, they are usually longer than bare imperfectives. To control the length of imperfective forms of the critical words, 50% of them had a bare imperfective form and the other 50% of the critical words had a secondary imperfective form.

What about perfectives in Polish? The most productive way of creating perfectives is by adding a prefix to a bare imperfective form, e.g., *pisać_{impf}* ‘to write’ – *na-pisać_{perf}* ‘to finish writing’. This perfectivizing strategy makes a derived perfective form longer than its bare imperfective base. The second possibility of forming a perfective form is by using a specific

(perfectivizing) semelfactive morphology; e.g., *kichać_{impf}* ‘to sneeze (several times)’ – *kich-nq-ć_{perf}* ‘to sneeze once’. The third strategy is to alternate a stem of the secondary imperfective form which usually contains a lexical prefix, e.g., *[[podpis_{perf}]+ywa-ć]_{impf}* ‘to sign’ (either a continuous reading or a habitual reading) – *[pod-[pisać_{impf}]]_{perf}* ‘to sign’. Using the latter two ways of forming perfective aspectual forms guarantees that the perfective members of the respective aspectual pairs are shorter or at least as long as their imperfective counterparts. To control the length of perfective forms of the critical words, 50% of them were formed by adding a prefix to a bare imperfective stem and the other 50% of the critical words were formed by alternating a stem of the corresponding non-semelfactive or secondary imperfective form.

2.2 Experimental Procedures

Participants 43 Polish native speakers (29 females, mean age 23.9, range 18-37 years) were recruited at University of Wrocław and received partial course credit for their participation in the experiment. All of them were right-handed according to the Edinburgh Handedness Inventory (Oldfield 1971) and had normal or corrected vision. None had neurological or psychiatric disorders or reported neurological traumas.

Procedure Participants were tested individually in one session. The whole experiment (including the application of electrodes) lasted for approximately 90 minutes. Following the application of the EEG electrodes, subjects were seated in front of a Samsung 22” computer LCD computer screen approximately 1 m away. All stimuli were presented in a white courier font, size 48, on a black background using Presentation software.

The experimental session was preceded by instructions and a trial session. As part of the instructions the participants were asked not to move or blink while a sentence was displayed. They were informed that the sentences would be presented segment by segment and that each sentence would be followed by an acceptability judgment question. The participants were instructed to provide their judgments as fast as possible. They were also instructed about which button on the Razor keyboard corresponded to which answer and which index finger they should use. To avoid the effects of lateralized readiness potential half of the participants were performing the task with the right hand, and the other half with the left hand.

After reading a written instruction the participants received a practice block with several sentences related to the experiment to familiarize each subject with the task. After practice, the participants received explicit feedback about the errors they made. The trial session was followed by six experimental blocks containing 50 sentences each. After each block there was a pause to give subjects the opportunity to relax.

Each trial consisted of the following events: A fixation cross appeared in the center of the screen for 1000 ms, after which a stimulus sentence was presented in a word-by-word or segment-by-segment (in the case of prepositional phrases) manner. Each word/segment appeared in the center of the screen for 550 ms, followed by a short blank screen interval. Sentence-ending words appeared with a full stop. Every sentence was accompanied by an acceptability judgment question. The possible answers were: ACCEPTABLE, UNACCEPTABLE, I DO NOT KNOW. After 4000 ms the next trial started automatically.

The questions were used to control the level of attention. In Condition 1 (control condition) in sets A and B the expected answer was ACCEPTABLE. In Condition 2 (morphological mismatch condition) the expected answer was UNACCEPTABLE. In the case of Condition 3 (pragmatic/semantic mismatch condition) the judgments were more delicate so we did not a priori assume any correct answer. This means that only in Conditions 1 and 2 the high number of incorrect answers could be the reason for throwing out the data from the

analysis since it would indicate that a subject paid no or little attention. In contrast, in Condition 3 all the answers were considered possible and relevant for further analysis. No participant was rejected because of the high number of incorrect answers, indicating that they were indeed paying attention above the chance level.

EEG recordings The EEG-activity was measured with 24 Ag/AgCl-electrodes which were attached to the scalp using the the Easycap system at Fz, FCz, Cz, CPz, Pz, POz, FC1, F3, C3, P3, O1, FC5, CP5, F7, P7, FC2, F4, C4, P4, O2, FC6, CP6, F8, P8. The ground electrode was positioned at AFz. Electrode positions were chosen in accordance with the international 10/20 system (Jasper 1958). Signals were referenced to A1 electrode (left mastoid) and later re-referenced to the average of left (A1) and right (A2) mastoid. Horizontal eye activity was measured by placing two electrode 2 cm lateral to the right (EOGR) and the left (EOGL) canthus. Vertical eye activity was measured by placing two electrodes 3 cm above (EOGU) and below (EOGD) the pupil of the right eye. Electrode impedances were kept below 5 k Ω . All electrophysiological signals were digitized with a frequency of 250 Hz. High cut-off filter 30 Hz was used. The ERPs were filtered off-line with 10 Hz low pass for the plots, but all statistical analyses were computed on non-filtered data.

During the visual inspection of the quality of the recorded data obtained for each participant, we decided to exclude the data of four participants because of the high number of artifacts.

3 Results

3.1 Behavioral Results

The grammatical sentences in Condition 1/Set A with imperfective main verbs and simultaneous converbs were correctly judged as ACCEPTABLE in 74,3% and the ungrammatical sentences in Condition 1/Set A with imperfective main verbs and incorrectly formed simultaneous converbs were correctly judged as UNACCEPTABLE in 73,5%. Interestingly, in the case of anterior converbs there were more erroneous answers. The grammatical sentences in Condition 1/Set B with perfective main verbs and anterior converbs were correctly judged as ACCEPTABLE in 71,7% and the ungrammatical sentences in Condition 2/Set B with incorrectly formed anterior converbs were correctly judged as UNACCEPTABLE in 64,9%. It thus seems that the grammatical status of sentences with anterior converbs is less obvious to the native speakers, a tendency which has been confirmed by the results obtained in an additional acceptability rating study (see section 4.1 below). As for the sentences with pragmatic/semantic mismatches, the sentences with imperfective main verbs and correctly formed anterior converbs in Condition 3/Set A (the “inception” condition) were judged as ACCEPTABLE in 62,32%, while the sentences with perfective main verbs and correctly formed simultaneous converbs in Condition 3/Set B (the “inclusion” condition) were judged as ACCEPTABLE in 83,13%. Thus, as it seems, the “inclusion” condition is more acceptable than the “inception” condition, a tendency which has been confirmed by the results obtained in an additional acceptability rating study (see section 4.2 below).

Table 3 Summary of the behavioral results

Set	Condition	Total number of the obtained answers		
		ACCEPATABLE	UNACCEPATABLE	I DO NOT KNOW
A.	1. Control ✓SIM converb	74,3%	17,5%	8,2%
	2. Morphological mismatch *SIM converb	18,7%	73,5%	7,8%
	3. Semantic/pragmatic mismatch “inception” imperfective + ✓ANT converb	62,32%	28,18%	9,51%
B.	1. Control ✓ANT converb	71,7%	24,6%	3,7%
	2. Morphological mismatch *ANT converb	28,9%	64,9%	6,2%
	3. Semantic/pragmatic mismatch “inclusion” perfective + ✓SIM converb	83,13%	12,7%	4,17%

3.2 ERP Results⁴

3.2.1 ANOVA via ROIs

We defined the following regions of interest (ROIs): *left-anterior* (F3, F7, FC1, FC5), *central-anterior* (C3, C4, Cz, FCz, Fz), *right anterior* (F4, F8, FC2, FC6), *left posterior* (CP5, O1, P3, P7), *central posterior* (CPz, O2, POz, Pz), *right posterior* (CP6, O2, P4, P8), *midline* (CPz, Cz, FCz, Fz, POz, Pz). The midline ROI was not relevant for further analysis. Mean voltages for the single ROIs were calculated from the averages of all participants. The time windows for our analysis of the two morphological and two semantic/pragmatic (“inclusion” and “inception”) mismatches were selected on the basis of visual inspection of average wave forms. For each chosen time window, we performed a paired *t*-test of the mean voltages in all six ROIs. Analyses were performed in a hierarchical fashion, i.e., only statistically significant interactions were resolved. In order to avoid excessive Type I errors due to violations of sphericity, we applied the correction of Huynh and Feldt (1970) when the analysis involved factors with more than one degree of freedom in the numerator (see also Huynh and Feldt 1976).⁵

Results for Comparison 1 (*Condition 2/Set A (morphological violation) vs. Condition 1/Set A (control)*) In Fig. 1 a very strong positive-going component is present between 600 and 1000 ms following word onset in all locations with a peak at 800 ms. The effect is the strongest in the left, central and right posterior ROIs. Given the positive deflection of the

⁴ We thank Felix Golcher and Anna Czypionka from the Humboldt-University of Berlin for the help with statistics.

⁵ We also applied the Greenhouse-Geisser correction (see Geisser and Greenhouse 1958 and Greenhouse and Geisser 1959).

reported ERP waves and their characteristic posterior distribution as well as their latency, the observed ERP pattern would correspond to the P600 component.

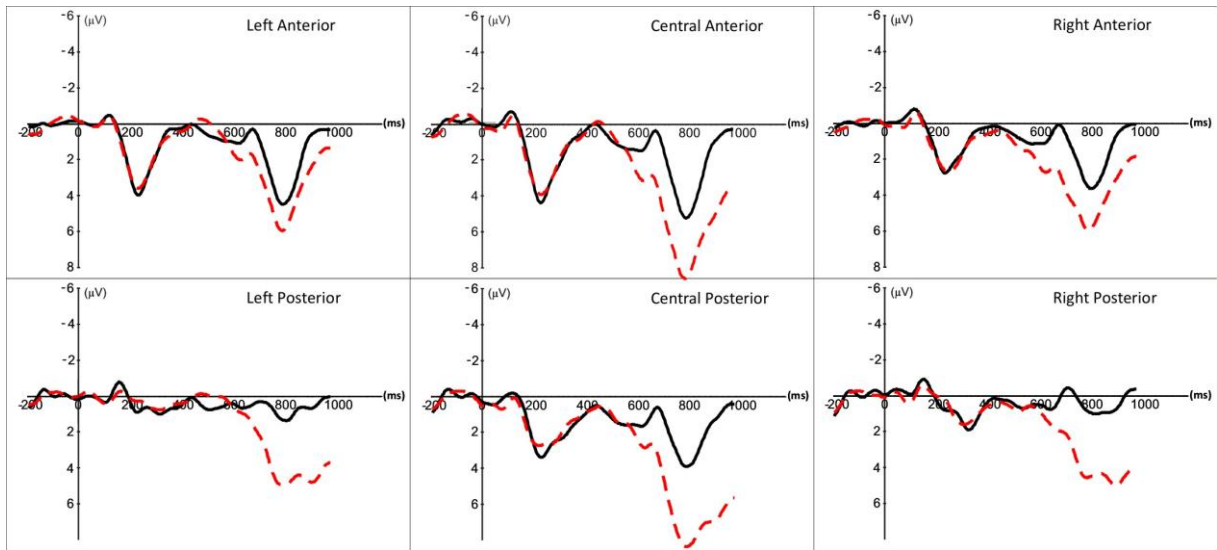


Fig. 1 ERP patterns from the onset of the critical word (converb) up to 1000 ms. The solid line shows the control conditions, the broken line the critical one.

There was main effect of Condition ($F(1,18)=29.25$, $p<0.001$) and ROI ($F(5, 90)=13.19$, $p<0.001$), and an interaction between Condition and ROI ($F(5, 90)=16.39$, $p<0.001$). The statistical analysis of the P600 effect in the time window 600-1200 ms revealed an effect of Condition in all ROIs: In the central anterior ROI ($t(18)=-4.59$, $p<0.001$), in the right anterior ROI ($t(18)=-3.99$, $p<0.001$), in the left posterior ROI ($t(18)=-5.81$, $p<0.001$), in the central posterior ROI ($t(18)=-7.32$, $p<0.001$), in the right posterior ROI ($t(18)=-6.49$, $p<0.001$).

Results for Comparison 2 (Condition 2/Set B (morphological violation) vs. Condition 1/Set B (control)) In Fig. 2 a positive-going component (P600) was present between 700 and 900 ms (post onset) following word onset in central posterior and right posterior ROIs. However, it was preceded by a negative component within 300-500 ms (post onset). The negative component was the strongest in the central anterior and left anterior ROIs, though the effect was statistically significant also in the right anterior and left posterior ROIs. Given the negative deflection of the reported ERP waves peaking between 300 and 500 ms as well as their characteristic bilateral distribution, the observed ERP pattern would most probably correspond to the N400 component.

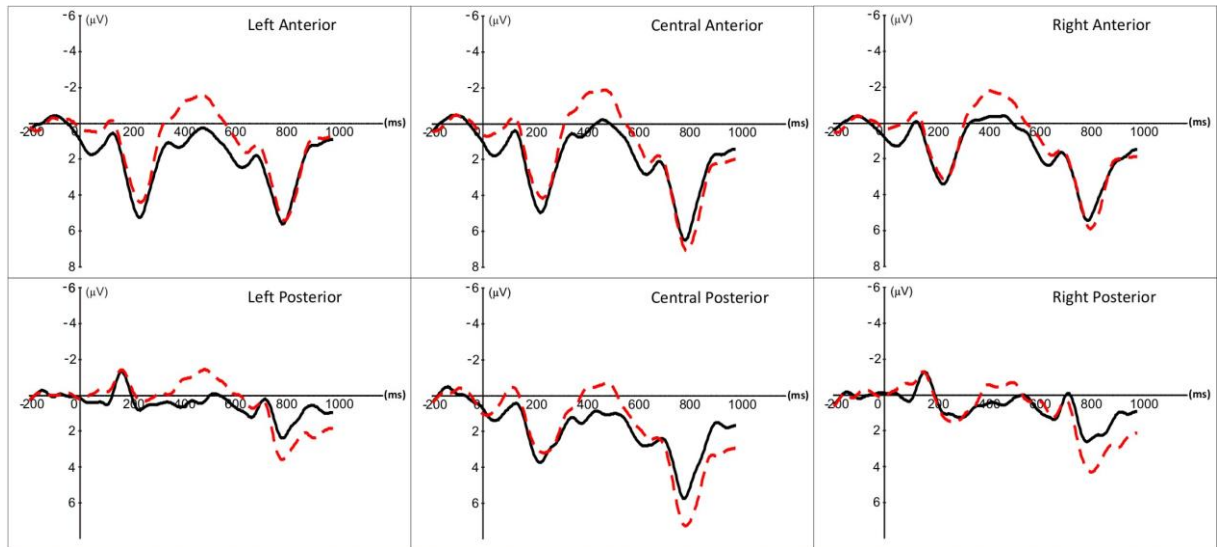


Fig. 2 ERP patterns from the onset of the critical word (converb) up to 1000 ms. The solid line shows the control conditions, the broken line the critical one.

Regarding the time window 300-500 ms, there was main effect of Condition ($F(1,19)=7.53$, $p<0.05$) and ROI ($F(5, 95)=4.72$, $p<0.001$), and an interaction between Condition and ROI ($F(5, 95)=3.2$, $p<0.05$). The statistical analysis of the N400 effect in this time window revealed an effect of Condition in the following ROIs: In the left anterior ROI ($t(19)=3.29$, $p<0.01$), in the central anterior ROI ($t(19)=2.9$, $p<0.01$), in the right anterior ROI ($t(19)=2.78$, $p<0.05$), in the left posterior ROI ($t(19)=2.46$, $p<0.05$).

As for the time window 700-900 ms, there was no effect of Condition but there was a strong effect of ROI ($F(5, 95)=12.28$, $p<0.001$), and a weak effect of an interaction between Condition and ROI ($F(5, 95)=3.16$, $p<0.05$). The statistical analysis of the P600 effect in this time window revealed a marginally significant effect of Condition in the central posterior ROI ($t(19)=-1.91$, $p=0.07$) and in the right posterior ROI ($t(19)=-1.91$, $p=0.07$).

Results for Comparison 3 (Condition 3/Set A (“inception”) vs. Condition 1/Set B (control))
There was no effect of Condition and no effect of an interaction between Condition and ROI. But there was a strong effect of ROI ($F(5, 185)=26.0015$, $p<0.001$). However, as will be pointed out in section 3.2.2 below, we obtained statistically relevant effects for this comparison while using a generalized additive modeling.

Upon visual inspection we noticed a positivity trend which turned out to be statistically most significant in the left posterior ROI: at the electrode sites P7 ($p<0.05$) and P3 ($p=0.07$). In Fig. 3 a positive-going component (P600-like) is present between 700 and 900 ms following word onset at the electrode site P7. Given the positive deflection of the reported ERP waves and their posterior distribution as well as their latency, the observed ERP pattern would most likely correspond to the P600 component.

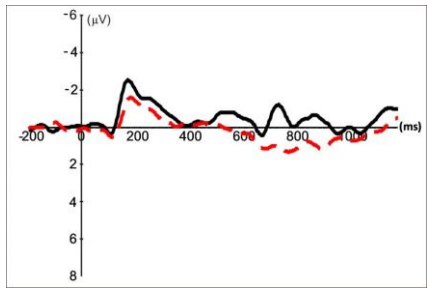


Fig. 3 ERP pattern from the onset of the critical word (converb) up to 1200 ms at the electrode site P7. The solid line shows the control conditions, the broken line the critical one.

Results for Comparison 4 (Condition 3/Set B (“inclusion”) vs. Condition 1/Set A (control))

In Fig. 4 a negative-going component is present between 250 and 500 ms following word onset at the electrode site Pz. Given the negative deflection of the reported ERP waves peaking between 300 and 500 ms and their (central) posterior distribution, the observed ERP pattern would most probably correspond to the N400 component.

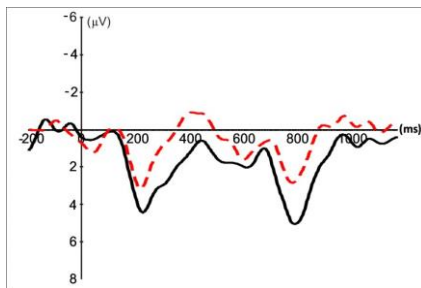


Fig. 4 ERP pattern from the onset of the critical word (converb) up to 1200 ms at the electrode site Pz. The solid line shows the control conditions, the broken line the critical one.

There was an effect of Condition ($F(1,37)=4.51$, $p<0.05$) and ROI ($F(5, 185)=3.75$, $p<0.01$), but there was no effect of an interaction between Condition and ROI. The observed negativity was the strongest in the central posterior ($p<0.01$) and left posterior ROIs ($p<0.05$) (especially at the following electrode sites: Pz ($p<0.01$), POz ($p<0.01$), P3 ($p<0.01$), CPz ($p=0.01$), less strongly at C3 ($p<0.05$), Cz ($p<0.05$)). However, as will be pointed out below in section 1.3.2.2, we obtained statistically relevant effects for this comparison while using a generalized additive modeling.

Table 4 summarizes the found ERP results.

Table 4 Summary of the ERP results

	Morphological mismatches	Results
Comparison 1	<i>Condition 1/Set A (control) vs. Condition 2/Set A (morphological violation)</i>	P600
Comparison 2	<i>Condition 1/Set B (control) vs. Condition 2/Set B (morphological violation)</i>	N400 + late positivity trend (a P600-like component)
	Pragmatic mismatches	Results
Comparison 3	<i>Condition 1/Set B (control) vs. Condition 3/Set A (“inception”)</i>	late positivity trend (a P600-like component)
Comparison 4	<i>Condition 1/Set A (control) vs. Condition 3/Set B (“inclusion”)</i>	negativity trend (an N400-like component)

Problems with ANOVA and the Motivation for GAMs The usual method (ANOVA via ROIs) has shortcomings.⁶ If the effect of interest is distributed between neighboring ROIs or occurs only in a subset of electrodes of one ROI, the ROI-wide averaging can easily mask it. If, on the other hand, ROIs are trimmed to fit the observed effects, the results might not be treated as completely credible. Furthermore, ROIs limit the maximal resolution to the size of the ROIs. Another drawback is that spatial relationships between electrodes or ROIs are ignored. They are eliminated by sphericity corrections. If we want to overcome these problems, it seems reasonable to use the coordinates of the electrodes directly as a continuous predictor variable. In that way the spatial relationships are accounted for, since neighboring electrodes have similar *X* or *Y* values, but farther apart ones do not. An alternative solution could be to use linear regression. An immediate problem, however, is that ERP-effects will hardly yield potentials which steadily grow or fall with *X* or *Y* coordinates. It is more likely that there will be regions of higher potentials and regions of lower potentials. These “hills” and “valleys” can have arbitrary shapes. Up to a certain point we could model them by higher order polynomials. The results should be qualitatively similar to the ones presented below but less elegant and only useable as long as the measured effect is limited to a single wide peak. GAMs (generalized additive modelings) are designed to fit problems like the one we have here. They use splines or smoothers, i.e., rather flexibly shaped functions, usually consisting of several pieces glued together. For the analysis reported below in section 3.2.2 we used so-called “penalized splines”. The algorithm automatically tries to find a maximally smooth representation still describing the data adequately. Another big advantage of the GAMs used here is that it is easy to add a component which describes the personal differences by means of random effects.

3.2.2 GAM

Given the shortcomings of the repeated-measures ANOVA pointed out above, we additionally used generalized additive modeling as implemented by the *mgcv* package (see Wood 2011 for generalized additive model method; Wood 2004 for strictly additive GCV based model

⁶ We thank Felix Golcher for discussing these issues with us.

method and basics of gam; Wood 2006 for overview; Wood 2003 for thin plate regression splines; Wood 2000 is the original method, but no longer the default). In this model the electrodes are not grouped into ROIs. Instead each electrode is identified by an x and y coordinate. These are taken from an approximate two dimensional projection of the electrode positions on the scalp; see Fig. 5.

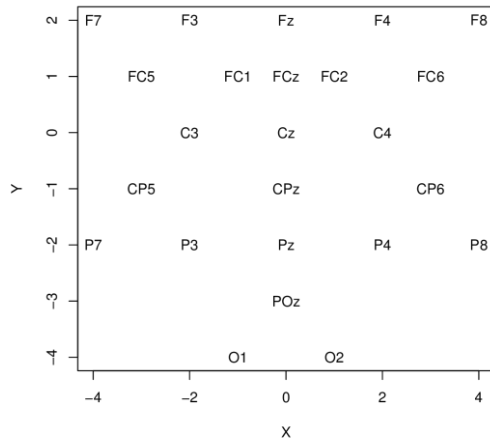


Fig. 5 The electrodes are positioned at approximate x and y coordinates

The main advantage of this approach is that evidence from neighboring electrodes adds up without the diminishing effects of arbitrary ROI-borders. Furthermore, two continuous predictors (x and y) “eat up” fewer degrees of freedom than 24 electrodes or six ROIs. The electrode potentials are modeled as a sum of the following components:

1. A contribution adjusting the difference due to the condition.
2. A two dimensional function modeling the spatial dependencies. It is allowed to have as many peaks and whatever shape necessary to describe the data.
3. Another two dimensional function modeling the differences of the spatial distributions within the two conditions.
4. An adjustment for every subject. Some subjects have higher potentials than other.

The optimal model was selected on the basis of AIC (Aikake Information Criterium). For all relevant comparisons it turned out that all the mentioned contributions lead to low AIC, which means that they constitute good models.

Results for Comparison 1 (*Condition 2/Set A (morphological violation) vs. Condition 1/Set A (control)*) The selected model leads to a significant Condition effect with Condition 2/Set A increased by 3.6355 (in the chosen time window 600-1200 ms post onset). The p -value here is $2.11 \cdot 10^{-12}$ (Wald test). The smoothing terms also have very low p -values ($= 2.50 \cdot 10^{-14}$). That implies a significantly different spatial distribution of potential within the two conditions. The deviance explained by the model is 83,6%.

Results for Comparison 2 (*Condition 2/Set B (morphological violation) vs. Condition 1/Set B (control)*) The selected model leads to a significant Condition effect with Condition 2/Set B lowered by 0.51868 (in the chosen time window 300-500 ms post onset). The p -value here is $< 2 \cdot 10^{-16}$ (Wald test). The smoothing terms also have very low (approximate) p -values ($< 2 \cdot 10^{-16}$). That implies a significantly different spatial distribution of potential within the two conditions. The deviance explained by the model is 45,3%.

As for the time window 700-900 ms, the selected model leads to a significant Condition effect with Condition 2/Set B increased by 0.35977. The p -value here is $9.64 \cdot 10^{-8}$ (Wald test). The smoothing terms also have very low p -values ($= 3.33 \cdot 10^{-8}$). That implies a significantly different spatial distribution of potential within the two conditions. The deviance explained by the model is 80,6%.

Results for Comparison 3 (*Condition 3/Set A (“inception”) vs. Condition 1/Set B (control)*)
The selected model leads to a significant Condition effect with Condition 3/Set A increased by 0.9750 (in the chosen time window 700-900 ms post onset). The p -value here is 0.0531 (Wald test). The smoothing terms also have low (approximate) p -values (< 0.001). That implies a significantly different spatial distribution of potential within the two conditions. The deviance explained by the model is 90,3%.

Results for Comparison 4 (*Condition 3/Set B (“inclusion”) vs. Condition 1/Set A (control)*)
The selected model leads to a significant Condition effect with Condition 3/Set B lowered by 1.9025 (in the chosen time window 250-500 ms post onset). The p -value here is $5.97 \cdot 10^{-7}$ (Wald test). The smoothing terms also have very low (approximate) p -values ($< 5 \cdot 10^{-6}$). That implies a significantly different spatial distribution of potential within the two conditions. The deviance explained by the model is 79%.

4 Discussion

4.1 Morphological Mismatches

We obtained the following results for the morphological mismatches: (i) for the combination of the simultaneity converbial morpheme *-qc* and a wrong perfective verbal stem we got a P600 component (see Fig. 1) and (ii) for the combination of the anteriority converbial morpheme *-wszy* and a wrong imperfective verbal stem we got a combined effect: an N400 followed by late positivity (P600) (see Fig. 2). A surprising fact is that we obtained different ERP signatures for two apparently analogous morphological violations. Recall from section 1.1 that converbial morphemes in Polish impose specific selectional restrictions as to what kind of an aspectual verbal stem they can be combined with: the anteriority morpheme *-wszy* selects for a perfective verbal stem, while the simultaneity morpheme *-qc* selects for an imperfective verbal stem. Given that in Polish every verb is marked either by perfective or imperfective aspect, we should expect that violating these selectional restriction by combining the simultaneity morpheme *-qc* with a perfective verbal stem and the anteriority morpheme *-wszy* with an imperfective verbal stem should induce the same kind of ERP effect, contrary to fact.

Comparison 1 Why do we observe a P600 for the first morphological violation in which a simultaneity converbial morpheme is combined with a wrong aspectual stem? The P600 is traditionally taken to reflect problems with syntactic or semantic composition at the phrasal level. According to this standard view, we could assume that the P600 elicited by Condition 2 in Set A, as compared to the control condition, reflects a difficulty in the morpho-syntactic integration of two elements (the simultaneity converbial morpheme and a wrong aspectual stem). This difficulty in turn resulted from specific semantic selectional restrictions imposed by the converbial morpheme as to the aspectual form of the verbal stem it was to be combined with at the phrasal level.

Comparison 2 Concerning the apparently analogous morphological violation in Condition 2 Set B as compared to the control condition, the same explanation could be proposed for the observed late positivity, which in this case would reflect a difficulty in the morpho-syntactic integration of the anteriority converbial morpheme with a wrong aspectual form. How to account for the fact that for this combination, there is an additional N400? This result can be caused by the fact that anterior converbs are generally less frequent than simultaneous converbs. For instance, if you look at the frequency of occurrences of both kinds of converbs used in our experiment in the Polish National Corpus IPI PAN (2nd edition, 250 M segments; see Przepiórkowski et al. 2012), it turns out that we get 12.990 occurrences altogether, whereby the simultaneous converbs make up 90,46% (11.750 occurrences) and anterior converbs only 9.54% (1240 occurrences).

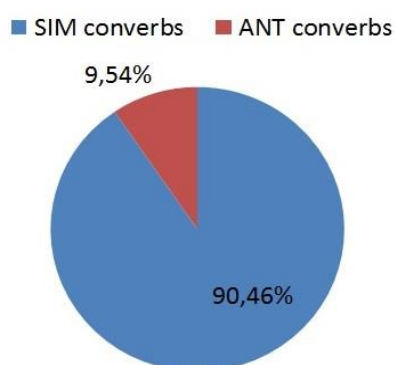


Fig. 6 Frequency of the occurrences of stimulus converbs in the IPI PAN corpus

Given this overwhelming difference in the frequency, the N400 could be attributed to the small frequency of anterior converbs as such. Along the lines of Federmeier (2007) and Kutas et al. (2006), Lau et al. (2008), Barber and Kutas (2007), we are inclined to interpret the N400 component in our morphological violation with an anterior morpheme and an imperfective stem as reflecting the increased amount of cognitive resources invested in recognizing an anteriority converb (as a consequence of its being infrequent). This in turn results in a difficulty of retrieving the less frequent anterior converb from the lexicon. The low frequency of anterior converbs would account for the fact that we found an N400 in a morphological mismatch with anterior but not with simultaneous converbs.⁷ But how to explain the difference in the strength of the late positivity component in the two morphological mismatches? Recall that in the morphological mismatch with simultaneous converbs elicited a very strong P600, while late positivity in the morphological mismatch condition in set B was rather weak. Our initial intuition was that the contrast in the strength of P600 in two morphological conditions could be related to the fact that ungrammatical anterior converbs are more acceptable than ungrammatical simultaneous converbs. In order to confirm this intuition, we conducted an additional online questionnaire in which we compared the acceptability of grammatical simultaneous and anterior converbs and their ungrammatical

⁷ Notice that observed difference in the ERP patterns found for Comparison 1 and Comparison 2 cannot be possibly attributed to the fact that what goes wrong in the case of the anteriority morpheme combined with an imperfective stem is the lack of a perfectivizing prefix. In other words, as suggested by an anonymous reviewer, the appearance of the anteriority morpheme with an imperfective stem without a prefix may lead the parser to conclude that they have not heard the prefix correctly or missed it altogether and therefore to try and reconstruct it. This explanation is unlikely since – as was pointed out in section 2.1 – not every perfective verb contained a prefix and there were also imperfective verbs with prefixes. That is, the presence or absence of a prefix could not be the reason for expecting a perfective or imperfective form.

counterparts on the scale from 0 to 100. We prepared two sets of data. In the first set, tested converbs were used in sentences while in the second set they were tested in isolation. In the second set of data, we additionally included potentially grammatical simultaneous and anterior converbial forms formed from jabberwocky verbal stems and their respective potentially ungrammatical counterparts. The results of this questionnaire confirmed our initial intuition.

Acceptability rating In the first questionnaire we used the converbial sentences which were presented in the ERP experiment. The material consisted of 300 stimuli sentences which were divided into 5 lists, each of them containing 10 sentences per condition. Each participant saw altogether 90 sentences: 10 sentences x 6 conditions = 60 + 30 filler sentences. The conditions were the following: sentences with simultaneous converbs (no violations), sentences with simultaneous converbs with morphological violations, sentences with anterior converbs (no violations), sentences with anterior converbs with morphological violations, sentences with semantic/pragmatic violations – inception, sentences with semantic/pragmatic violations – inclusion. Forty 1st and 2nd year students from the University of Wrocław, all of them native speakers of Polish, took part in this online questionnaire study.

As for the sentences with morphological violations, the results are shown in Fig. 7. Interestingly, there is a rather big contrast in the mean acceptability scores obtained for sentences with simultaneous converbs without violations (72,66) and for simultaneous converbs with morphological violations (18,68). In contrast, there is a rather small difference in the mean acceptability scores obtained for sentences with anterior converbs without violations (60,85) and for sentences with anterior converbs with morphological violations (32,62). This result confirms our initial intuition that in spite of the analogous type of morphological violation in simultaneous and anterior converbs, the former are judged as much less acceptable than the latter.

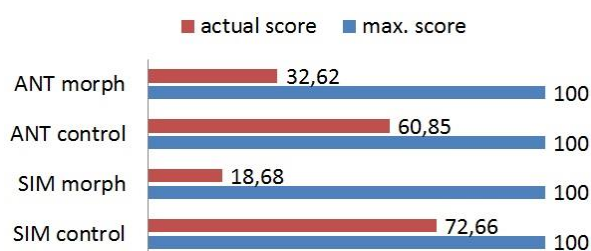


Fig. 7 Morphological mismatches in converbs used in sentences: acceptability rating on the scale from 0 to 100

In the second online questionnaire we tested converbs with and without morphological violations and in addition we used potentially grammatical simultaneous and anterior converbial forms formed from jabberwocky verbal stems and their respective potentially ungrammatical counterparts. The material consisted of 80 stimuli. Each participant saw altogether 100 words: 10 stimulus items x 8 conditions = 80 + 20 filler items (nominalizations). The conditions were the following: grammatical simultaneous converb, ungrammatical simultaneous converb, “potentially correct” nonsense simultaneous converb, “potentially incorrect” nonsense simultaneous converb; grammatical anterior converb, ungrammatical anterior converb, “potentially correct” nonsense anterior converb, “potentially incorrect” nonsense anterior converb. Thirty two 1st and 2nd year students from the University of Wrocław, all of them native speakers of Polish, took part in this online questionnaire study.

The results are shown in Fig. 8. In this questionnaire we obtained a similar pattern of acceptability ratings for real converbs as in the first questionnaire, i.e., anterior converbs with

morphological violations were judged as more acceptable than their simultaneous ungrammatical counterparts. However, all jabberwocky converbs regardless of whether they were potentially grammatical or not were judged as equally unacceptable (see Fig. 9).

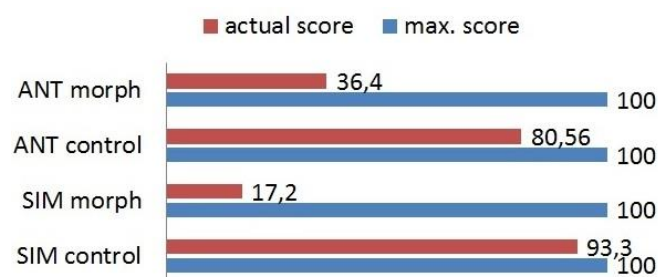


Fig. 8 Morphological mismatches in converbs used in isolation: acceptability rating on the scale from 0 to 100

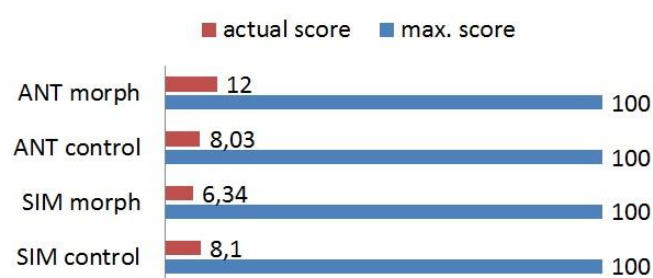


Fig. 9 Morphological mismatches in jabberwocky converbs used in isolation: acceptability rating on the scale from 0 to 100

To sum up, both questionnaires showed that there is a considerable difference in the acceptability rating of well-formed simultaneous converbs and well-formed anterior converbs, where the latter were evaluated as generally less acceptable than the former. Conversely, ill-formed simultaneous converbs turned out to be less acceptable than ill-formed anteriority converbs. The results from both online acceptability rating studies together with our corpus-based analysis of the frequency of both kinds of converbs point to a conclusion that people are less sensitive to morphological violations encountered in less frequent (and hence less familiar) forms. How does this observation correlate with our ERP results elicited in morphological violation conditions? Recall that the main question was why there is a contrast in the strength of P600 in morphological violation conditions. More precisely, why the P600 is stronger in the case of simultaneous ungrammatical converbs. Our scale-based acceptability rating online questionnaire revealed a dependency which in fact patterns with the findings reported in Yamada and Neville (2007), who show that morpho-syntactic violations which lead to a P600 in real language sentences do not emerge or are attenuated if used in jabberwocky contexts. This may be related to the fact that it is impossible to retrieve jabberwocky words from the lexicon (see also Coch et al. 2012 for a discussion about processing of nonwords as compared to real words). Following this line of reasoning, the morphological violations in anteriority converbs are judged as less fatal than violations of aspectual selectional restrictions of simultaneous converbs because the former are more difficult to retrieve from the lexicon (due to their low frequency of use) and consequently their selectional restrictions are less transparent. If selectional restrictions of anteriority converbs are less transparent, violating them is more difficult to evaluate and they are not perceived as strong violations. If this reasoning is on the right track, we may formulate a simple explanation of the contrast in the strength of P600 elicited for morphological violations

in simultaneous converbs and in anterior converbs. The latter are more difficult to retrieve from the lexicon, hence their selectional restrictions are not transparent and violating them is not perceived as fatal.

4.2 Pragmatic/Semantic Mismatches

Recall from section 3.2 that we obtained two different ERP patterns for our pragmatic/semantic mismatches. “Inception” elicited a late positivity while “inclusion” led to a negativity trend.

Comparison 3 How to account for the late positivity engendered by Condition 3/Set A as compared to Condition 1/Set B?

Condition 3/Set A: Semantic/pragmatic mismatch (“inception”)

?Anna	szła	do pokoju	za-pali-wszy	papierosa	w pośpiechu.
Ann	walk.IMPF	to room	PERF-smoke-ANT.PRT	cigarette	in hurry
Lit.: ‘Ann was going to the room (while) having smoked a cigarette in a hurry.’					
Intended: ‘Ann started walking to the room after she had smoked a cigarette in a hurry.’					

Condition 1/Set B: Control

Anna	we-szła	do pokoju	za-pali-wszy	papierosa	w pośpiechu.
Ann	PERF-walk	to room	PERF-smoke-ANT.PRT	cigarette	in hurry
‘Ann entered the room (after) having smoked a cigarette in a hurry.’					

Out of the context, the Polish sentence in Condition 3/Set A should behave as English sentences reported by Brennan and Pykkänen (2010) as instances of inchoative coercion; cf. (4).

- (4) a. Without a doubt, the child cherished the precious kitten. (simple)
 b. Within a few minutes, the child cherished the precious kitten. (coercion)

The predicate *cherish* denotes a state. However, the context in (4b) it is enriched with a “begin-to-cherish” (inceptive) component to match the semantics of the completive adverbial *within a few minutes*. This mechanism that enriches the interpretation is usually referred to in the literature as “coercion”. Notice that not only states but also processes can undergo the process of inchoative coercion as in, for instance, (5) from de Swart (2011: 586).

- (5) John broke his leg in a car accident last year. Fortunately, it healed well, and in six months he was walking again. (inchoative reading of progressive process)

In a similar vein, the imperfective predicate *szła do pokoju* (‘was going into the room’) should be enriched with a “begin-to-go” (inceptive) component to match the requirement imposed by the anterior converb that the eventuality in the main clause should follow the eventuality in the converbial clause. This enrichment is necessary since the imperfective *szła do pokoju* (‘was going into the room’) denotes an ongoing process without any boundaries and thus we need to add a beginning component to be able to locate this eventuality after the converbial eventuality and by doing so to satisfy the temporal requirements of the anterior converb. This type of inceptive coercion has been recently tested in Brennan and Pykkänen’s (2010) self-paced reading and a subsequent magnetoencephalography (MEG) study for psych verbs in English. They found a reading delay associated with inchoative coercion and a distributed fronto-temporal effect around 300-500 ms for coercion. In an independent study, Bott (2010)

conducted an ERP experiment for additive coercion in German. The examples he used are illustrated in (6).

- (6) a. Vor zwei Stunden hatte der Förster die Falle entdeckt,
 before two hours had the ranger the trap discovered
 obwohl sie gut versteckt war.
 although it well hidden was
 ‘Two hours ago, the ranger had discovered the trap although it was hidden well.’
- b. In zwei Stunden hatte der Förster die Falle entdeckt,
 in two hours had the ranger the trap discovered
 obwohl sie gut versteckt war.
 although it well hidden was
 ‘In two hours, the ranger had discovered the trap although it was hidden well.’

(6b) is an instance of additive coercion which is defined by Bott (2010) as adding some part of an eventuality to the nucleus, in this particular case a preparatory phase is added to an achievement which results in an accomplishment. For this type of coercion Bott reports a sustained working memory LAN.

Notice that the coercion in the relevant Polish example (Condition 3/Set A) could be taken to be an instance of additive coercion since an inception is added to the nucleus of an eventuality. Given the finding reported by Bott (2010) for German, one could expect a similar effect for the Polish case. However, this is not what we found. Recall that this type of pragmatic/semantic mismatch in Polish engendered late positivity. So the question is why we observe positivity instead of negativity in Polish. In order to answer this question, we should take into consideration not only this particular experimental context but also look at how this context interacts with other properties of grammar specific to the languages at hand. There is indeed one important difference between Polish and German as far as their aspectual properties are concerned. While in Polish all verbs (with some minor exceptions) are obligatorily morphologically marked for either imperfective or perfective aspect, this is not so in the case of German where aspect is not morphologically manifested so the aspectual information is largely dependent on the lexical properties of a given verbal predicate and/or the context of use. The lack of morphological aspectual marking in German allows for more freedom in the interaction between lexical aspect and contextual information. In Polish, we predict that this freedom is more restricted by the presence of a specific morphological coding. Perfectivizing morphemes usually resist further (contextual) modification or enrichment due to their very specific semantics (perfective predicates denote atomic (episodic) eventualities). As far as imperfective forms are concerned, they have a less specific semantics as they potentially allow for different interpretations: progressive, iterative, habitual or even “statement-of-fact” telic interpretations. This latter observation is not new, but so far there has been no experimental (ERP) studies (in Polish) showing how much room for coercion there is in imperfective forms.

Coming back to the interpretation of the ERP signature in the context of pragmatic/semantic mismatch in which an anteriority morpheme should trigger an inceptive coercion on the matrix imperfective verb, one might wonder why this seemingly semantic incongruity does not result in a negative ERP component (of the sort reported by Bott (2010) for additive coercion in German). Surprisingly, we obtained instead late positivity which in earlier ERP studies were taken to indicate some morpho-syntactic violation, reanalysis or integration problems at the syntactic level. However, more recent ERP studies have reported a P600 for semantic anomalies (see, among others, Kim and Osterhout 2005, Hagoort et al. 2009, Bornkessel-Schlesewsky et al. 2011) which makes our present finding not so surprising. Following Bornkessel-Schlesewsky et al. (2011: 148), we consider the possibility that the

positivity with a posterior scalp distribution reported by us for this particular semantic/pragmatic mismatch (inceptive coercion) reflects a categorization process based on binary decision. An N400 has been observed for semantic incongruities when there are many potential congruous continuations (as, for example in the case of Kutas and Hillyard's (1980) example *He spread the warm bread with socks* as opposed to – for example – *butter, jam, honey, etc.*). By contrast, when for a given semantic incongruity there is only one competing congruous continuation (as, for example, in *The opposite of black is nice* as opposed to *The opposite of black is white*, quoted from Bornkessel-Schlesewsky et al. (2011: 148)), a P300 is observed and it is taken to reflect the binary nature of the decision between a single congruous and a single incongruous continuation. Following Bornkessel-Schlesewsky et al.'s (2011) suggestion that late positivity could be taken to be a kind of a delayed P300, we assume a similar interpretation for our late positivity observed in the Polish case of inceptive coercion discussed in this paper. More specifically, we take late positivity in our study to reflect a binary decision or, in other words, a competition between two forms: a congruous perfective form of the matrix predicate, which would explicitly express the inception, and an incongruous imperfective form, which could potentially express the inception provided it undergoes a coercion process. Notice if our interpretation is on the right track, this would mean that there is a specific ERP signature for a morphological blocking effect, namely late positivity.

Comparison 4 How to account for the negativity (N400) engendered by Condition 3/Set B as compared to Condition 1/Set A?

Condition 3/Set B: Semantic/pragmatic mismatch (“inclusion”)

?Anna	we-szła	do pokoju	pałac	papierosa	w pośpiechu.
Ann	PERF-walk	to room	smoke.IMPf-SIM.PRT	cigarette	in hurry

‘Ann entered the room while smoking a cigarette in a hurry.’

Condition 1/Set A: Control

Anna	szła	do pokoju	pal-ąc	papierosa	w pośpiechu.
Ann	walk.IMPf	to room	smoke.IMPf-SIM.PRT	cigarette	in hurry

‘Ann was going to the room (while) smoking a cigarette in a hurry.’

As was pointed out in section 1.2, imperfectives denote unbounded eventualities and by doing so they can overlap with the eventuality denoted by the simultaneous converb. In contrast, perfective aspect denotes atomic (episodic) events which cannot be understood as overlapping with the eventuality denoted by a simultaneous converb. Despite this fact the sentence in Condition 3/Set B is not ungrammatical and it is also not pragmatically implausible since the atomic eventuality denoted by the perfective predicate in the main clause can be understood as being included in the converbial eventuality. Given the fact that the sentence in Condition 3/Set B is a plausible sentence, the question is why we observe a negativity (an N400) there. Since the only difference between these two sentences is the preferred simultaneity versus less preferred inclusion, we take this to mean that the latter is more costly for the parser and this is reflected in the N400 component. One might wonder why we did not find late positivity for the Comparison 4 given that – just as it was the case in the previous case of a pragmatic/semantic mismatch (Comparison 3) where inception was anticipated – it seems that this is also a case of a binary decision. Notice, however, that in the case of Comparison 4 we do not have any blocking effect where one form is strongly dispreferred because there is a competing better form which expresses the intended meaning in a more precise way. In the case at hand it is not so that one form is blocked and therefore dispreferred. On the contrary, both forms, imperfective and perfective, are equally good but the ERP signature that we found indicates that one form (the perfective) results in an increased processing cost. Interestingly,

our online acceptability rating study introduced in the section 4.1 revealed that “inclusion” contexts were judged as more acceptable than “inception” contexts (see Fig. 10).

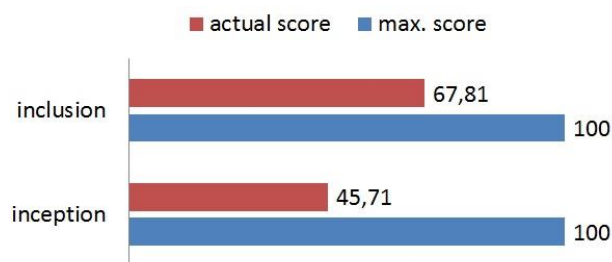


Fig. 10: Pragmatic mismatches in converbs used in sentences: acceptability rating on the scale from 0 to 100

5 Conclusion

Recall from section 1.1 that we made three predictions as to morphological conditions. We expected either a P600 as a component which is triggered by morpho-syntactic violations which are semantically based, or a P600 (sometimes in combination with a LAN) as a component usually found in morpho-syntactic and semantic tense violation contexts, or a biphasic 200-400 ms posterior and left central negativity and a P600 (instead of a LAN or N400) found for agreement violations of grammatical aspect (in Chinese). Moreover, our prediction was that whatever outcome is found it should be the same for both morpho-syntactic violations: the simultaneity morpheme *-qc* combined with a perfective verbal stem and the anteriority morpheme *-wszy* combined with an imperfective verbal stem. None of these predictions turned out to be entirely confirmed. Beginning with the last expectation, instead of one common outcome for both morphological violations, we found a strong P600 component for one morphological condition (Comparison 1) and an N400 + a late positivity (P600) for the second morphological condition (Comparison 2). Moreover, these two morphological conditions differed in the strength of the P600 component. As it comes to the interpretation of P600, we adopted a traditional assumption that it reflects an integration difficulty at the morpho-syntactic level. As far as the difference in the strength of the P600 component in both morphological conditions is concerned, we attributed it to the fact that the morpho-syntactic violations are attenuated when a given form is less frequent and hence less familiar. The reasoning behind this conclusion is that we are less sensitive to the lexically encoded grammatical constraints responsible for a given violation for those lexical items which are more difficult to retrieve from the lexicon. We confirmed the contrast in the frequency and acceptability of converbs used in the first and in the second type of morphological violation condition in the additional corpus-based and online questionnaire studies. Additionally, the difference in the frequency of occurrences of simultaneous and anterior converbs was manifested in the presence of the N400 component in the latter.

Coming back to the predictions made in sections 1.2 for our semantic/pragmatic mismatches for Comparison 3 we expected a kind of additive (more precisely, inceptive) coercion which – as reported in the literature (see Bott 2010) – gives rise to a working memory LAN in German. Alternatively, we speculated that because of the difference in the aspectual morphology between Polish and German, overt aspectual morphology in Polish might block an implicit repair process (coercion), thus probably giving rise to a different ERP component from that found for coercion (in German). The latter expectation has been corroborated by our ERP study in which we found a late positivity for the “inception” condition. Following Bornkessel-Schlesewsky et al.’s (2011), we assumed that the late

positivity could be taken to be a kind of a delayed P300. More specifically, we took the late positivity in our study to reflect a binary decision or, in other words, a competition between two forms: a congruous perfective form of the matrix predicate, which would explicitly express the inception, and an incongruous imperfective form, which could potentially express the inception provided it undergoes a coercion process.

Regarding Comparison 4, our initial hypothesis was that it would be more difficult to create an “inclusion” relation between the eventuality in the main clause and the eventuality in the converbial clause to satisfy the temporal ordering relation requirement imposed by the simultaneous converb, as opposed to a situation in which both the eventuality in the main clause and the eventuality in the converbial clause are perfectly overlapping. In fact we found a negativity trend (N400), which we took to reflect the fact that it is more difficult to create an inclusion relation between two eventualities in a context with a simultaneous converb and a perfective main verb than to create a simple overlapping temporal relation between the main clause eventuality (denoted by an imperfective predicate) and the converbial eventuality.

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