Sensorimotor Behaviour Reflects Lexical and Grammatical Aspect in Czech: An Eye Tracking Study

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1. Introduction

Thinking and speaking about events is a process tightly connected with time perception. We can express when an event has occurred with respect to other events, whether it was a durative or a one-time event, whether it was an ongoing or already finished event, etc. Every human language has its own way and extent to which this complex temporal structure of experienced events is expressed. Upon hearing a story we construct a mental representation of the communicated event (e.g. Givón 1992). Some studies show that this construction already evolves during online processing, thanks to instantly accessible language processing cues (Altman and Kamide 1999, Ferretti, McRae and Hatherell 2001, McRae, Ferretti and Amyote 1997). These cues are employed to capture the intricate temporal structure of the story, for instance. They arise from the interplay of the three basic linguistic components (structure, meaning and function) and as such are consistent with a constructional view of language (e.g. Fillmore 1988). Even subtle changes of any of the linguistic cues may lead to a different mental representation. Examples of the sources of grammatical markers and lexical categories from which the linguistic cues arise are grammatical and lexical aspect. In the linguistic field, a lot of attention has been paid to analyses of how those sources of temporal cues function within a language system. However, there is a lack of empirical data on how grammatical and lexical aspect interact, and what the effects of such an interaction are. The present study aims to investigate the link between the complex system of temporal cues and sensorimotor representation in Czech speakers, with specific focus on grammatical verb aspect and so-called event telicity, i.e. lexical aspect, all of which will be further described below.

1.1 Grammatical verb aspect

Grammatical aspect has the ability to refer to the temporal flow of situations. The dichotomy of imperfective and perfective verbs has been observed to occur in many languages to
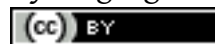
distinguish between ongoing and finished events (e.g. Comrie 1976). The difference between the two aspects can be ascertained through grammatical or lexical information (Croft 2012). The imperfective aspect gives the language user an internal view of event description, so that the various phases of the ongoing event remain accessible (Langacker 1987). To describe the effects of aspect, some researchers have proposed a cinematic metaphor, comparing the imperfective aspect to a movie (Kruisinga and Erades 1955). To the contrary, the perfective aspect refers to an event as completed and projected to an indivisible unit without emphasizing its internal properties. Thus, the perfective aspect focuses only on the static end point. This distinction is widely accepted among researchers and supported by various studies on aspect (e.g. Comrie 1976, Dowty 1977, Langacker 1982, Schoorlemmer 1995, Borik 2002, Filip 2000).

In addition, psycholinguistic evidence shows that grammatical aspect influences the conceptualisation of the encountered event (Carreiras, Carriedo, Alonso, and Fernandez 1997, Coll-Florit and Gennari 2011, Ferretti, Rohde, Kehler and Crutchley 2009, Ferretti et al. 2007, Madden and Therriault 2009, Madden and Zwaan 2003, Magliano and Schleich 2000, Matlock 2010, Matlock 2011, Matlock 2012, Matlock et al. 2012). In one experiment of Madden and Zwaan (2003) using a visual word paradigm, users of language were asked to look at a screen with pictures showing finished or unfinished events, whilst hearing an event description employing either perfective or imperfective aspect. If the event was described in perfective aspect, subjects preferred looking at pictures with finished events, whereas they showed no specific preference in the imperfective condition. As the imperfective aspect allows for focus to be placed on different phases of an ongoing event, a more detailed mental representation is construed. Consistent with this claim, information about place (Ferretti et al. 2007) and characters (Carreiras et al. 1997) is more accessible while using the imperfective aspect rather than the perfective one. This is also supported by Matlock (2011), who found in her offline processing studies on grammatical aspect, that when asked to complete an imperfective sentence, participants consistently mentioned more details of the action they were referring to than in the case of a perfective sentence.

1.2 Event telicity

Events can be divided in two groups: telic and atelic. (Comrie 1976, Dowty 1979, Lyons 1977). A verb is considered telic if it describes an event which entails a specified endpoint (e.g. *reach, break, dress up).* The basic property of telic verbs is given by the inherent endpoint, without which the event would not be as it is. While speaking about reaching a mountain top, the final state is implied necessarily. Without being on the peak, i.e. attaining the final state, the top cannot be considered to have been reached. (Vendler 1976). Atelic verbs describe events which do not have an intrinsic endpoint, i.e. no delimitation of time and space (e.g. *lounge, stay, know).* Crucial to the traditional works on semantic features of verbs and predicates, Vendler's study (1967) distinguishes four basic semantic situations expressed by verbs. These are states (*know, love*), activities (e.g. *run, walk, drive a car*), accomplishments (e.g. break, write a letter) and achievements (e.g. *reach, recognize someone).* Table 1 shows how all the verb types are distinguished with respect to their temporal properties. Some researchers (e.g. Comrie 1976, Smith 1991) also include a fifth verb type, namely semelfactive verbs (e.g. *sneeze, fall).* However, this verb type shares the temporal properties central

to the current work with the accomplishments class. That is why here Vendler's (1967) classification will be used.

	Dynamic	Durative	Telic
State	−	+	−
Activityc	+	+	−
Accomplishment	+	+	+
Achievement	+	−	+

Table 1: Vendler's types of verbs distinguished with respect to their temporal properties

As follows from Table 1, the property of telicity is the only one that separates two classes that are identical in other respects, namely activities and accomplishments. Activities can involve various changes of state but do not entail an intrinsic endpoint. For example, the activity reading Russian literature does not reasonably imply a natural endpoint. In contrast, reading two chapters of *Anna Karenina* may take some time to finish, but entails a natural endpoint to be reached, making it an accomplishment. Verbs express situations, but one given verb can express more than one. Thus, the telic features distinguish between two different situations expressed by the verb from each other. Consequently, as the case of reading shows, lexical aspect can change independently from grammatical aspect and vice versa. The same holds also for Czech as the following example (1) shows:

(1) a. Petr píše$_{IPF}$ dva články za rok.

   Petr writes two articles per year.

   b. Petr psal$_{IPF}$ loni dva články, letos píše$_{IPF}$ čtyři.

   Petr wrote two articles last year, this year he writes four.

   c. Petr píše$_{IPF}$ letos dva články, příští rok bude psát$_{IPF}$ čtyři.

   Petr writes two articles this year, next year he will write four.

As we can see, situations which reach their natural endpoint can also be expressed by imperfective verbs (1b). In (1c), even though the activity could not be accomplished yet, its natural endpoint is expressed by the expectation of writing a specific number of articles next year.

Generally, among Czech linguists, the term telicity is not widely used in work on grammatical aspect, but those who deal with the affinity of grammatical and lexical aspect believe that these two categories are not symmetric in Czech. (Čermák 1997, Karlík, Nekula and Pleskalová 2002, Komárek et al. 1986, Němec 1958, Poldauf 1954; see Lehečková 2011 for a review).

Much more attention has been paid to lexical aspect outside the Czech linguistic region, where the topic of telicity has been widely addressed from a traditional linguistic point of view (e.g. Bach 1986, Bertinetto 2001, Borik 2006, Capelle 2004, Depraetere 1996, Dowty 1979, Guéron 2007, Guéron 2008, Lyons 1977, Mourelatos 1981, Nordenfeldt 1977, Vendler 1967, Verkuyl 1972, Verkuyl 1973, Xiao and McEnery 2006). However, a psycholinguistic approach has not been employed much to explore this phenomenon. Although we have a lot of materials which give us insight into how these categories work within language systems, there is a clear lack of empirical data that can tell us how these categories affect our mental representations. Additionally, existing studies from the field of cognitive psychology (e.g.

Feretti, Kutas and McRae 2007, Huette et al. 2014, Magliano and Schleich 2000) use verbs without distinguishing between the different classes of lexical aspect, which could be seen as a shortcoming.

1.3 Interaction between grammatical and lexical aspect

This work aims to investigate how the category of telicity and the morphosyntactic category of aspect interact with respect to our mental representation, and how this interaction is grounded in our sensorimotor experiences. Unfortunately, most of the empirical studies on grammatical and lexical aspect investigated only one of those verb properties. That is why it remains unclear how lexical aspect interacts with grammatical aspect to constrain representations. Only a few studies have addressed this issue (Gennari and Coll-Florit 2011, Pinango, Winnick, Ullah, and Zurif 2006, Piñango, Zurif, and Jackendoff 1999, Yap et al. 2009). In a study on Cantonese, a language rich in aspectual marking, Yap et al. (2009) demonstrated facilitated processing of events when the inherent telicity of accomplishments is matched with the perfective markers and its boundedness and completedness features. They also show imperfective facilitation when the durative character of activity verbs is matched with the imperfective markers which are featured by ongoingness. In other words, perfective sentences were processed faster and with higher accuracy if they were expressed by accomplishment verbs, whereas this was the case for imperfective sentences when activity verbs were used.

In another study, Becker et al. (2013) go beyond the Yap et al. (2009) findings by investigating grammatical aspect manipulation in short stories using accomplishment and activity verbs and finding out how resistant the effects of lexical and grammatical aspect are to the third basic source of temporal information, so-called time shifts proceeded by short (e.g. *She picked a tomato., She sneezed.* etc.) and long intervening events (She weeded the garden., She painted a picture.). The presumptions of the Becker at al. study are based on the findings that concepts preceding short shifts are more available later on in the discourse than those preceding long temporal events (Anderson, Garrod, and Sanford 1983, Bestgen and Vonk 1995, Ditman, Holcomb, and Kuperberg 2008, Kelter, Kaup, and Claus 2004, Zwaan 1996). Based on research investigating discourse availability measured by EEG (Ditman, Holcomb, and Kuperberg 2008), Becker and his colleagues assumed that in the case of the most accessible combination of temporal features of events, the N400 effect would be reduced. However, their own EEG data suggests that matching grammatical and lexical aspect does not make constructing mental representations of activities any easier. Still, there was a discourse availability advantage for imperfective accomplishments over perfective ones. This study does not offer convincing support to the Yap et al. (2009) study. This line of research thus remains to be continued to be able to identify which temporal-semantic features of events are critical for constraining the way aspect is represented.

1.4 Using eye tracking without visual task to investigate grammatical and lexical aspect

The measurement of eye movements has provided important basis for theories of language processing in various situations. Tannenhaus et al. (1995) found that visual processing is used while we process syntactic dependencies. Altman and Kamide (1999) found that eye movements differ based on the semantics of the processed sentences. We can measure a

wide range of ocular behaviour by the means of eye-tracking, such as path of eye movements, and number or duration of fixations on the screen. Given the previous findings on sensorimotor movements revealed by grammatical and semantical processing (e.g. Huette et al. 2014, Madden and Zwaan 2003, Mattlock 2010), there is reason to believe that language processing of grammatical aspect, lexical aspect and their possible combinations could be mirrored in eye movements in different ways.

Designing an eye tracking experiment is challenging, because crucial decisions on both visual and linguistic stimuli are required. It has been proven that the explicit visual stimuli can have such a strong bias on the participants that the comprehension is compromised (Hauk et al. 2004, Pulvermüller 2005, Zwaan and Taylor 2006, Bergen and Wheeler 2010). Thus, because there is no direct need for it, and to avoid the introduction of unwanted biases, the experimental design used here does not include an explicit visual task. In other words, I will have participants simply look at a blank screen, to investigate the effects of language processing on eye movements revealed by auditory linguistic stimuli only.

The absence of an explicit visual task and task constraints in this pilot experiment enables the investigation of eye movements that are not influenced and changed by any visual scene. Some neurological evidence suggests that explicit pictures of an action can provide a strong language bias. Concretely, research on mirror neurons, neurons which fire not only at the moment of performing an action, but also at the moment of seeing someone perform an action, can rise concern about the possible bias of an explicit visual task. Studies in humans using the MRI method suggest that mirror neurons are in humans found very close to the Broca's area (e.g. Kilner et al. 2009) which has led to suggestions that language has evolved from gesture learning and as such can be tightly connected with stimulation of the motor cortex. There is a theory regarding the connection between mirror neurons and language which states that the meaning of action-related words is rooted in brain areas devoted to the execution of those actions (e.g. Hauk, Johnsrude, Pulvermüller 2004, Hickok 2010). Experiments using TMS (transgranial magnetic stimulation) showed that stimulation of motor cortex affects also performance of lexical decision tasks. (Pulvermüller et al. 2005) The theory of mirror neurons makes connection not only between actual action and language, but also between seeing an action and the language, which would be the case of explicit visual tasks.

Methodologically, using more or less spontaneous eye movements to study the way in which grammatical and lexical aspect influence the semantic representation of space and time is quite novel. Arguably, by avoiding the often highly goal-oriented and constrained experimental setting that is characteristic of cognitive research, this experiment simulates a more natural situation, reminiscent of normal conversation, where people frequently listen to references to absent objects.

Similarly, Huette et al. (2014) used the blank screen paradigm method to see how eye movements revealed by spontaneous grammatical processing of aspect differ. In their study, sixty-three native speakers of English listened to short stories which were manipulated in terms of grammatical aspect, using the past progressive (e.g. *was walking*) and past simple (e.g. *walked*). These two tenses in English are the voluntary markers of grammatical aspect (Langacker 1982). The researchers used only auditory stimuli. They found remarkable differences in the processing of past progressive (imperfective) and past simple (perfec-

tive) stories indeed. They argued their results were in line with other experimental studies on grammatical aspect: processing of past progressive conditions produced eye movements that were more dispersed across the screen, had many areas of fixation and longer saccade paths, the processing of past simple conditions was accompanied by eye movements that covered a smaller screen area, had fewer areas of fixation and with shorter saccade paths.

Huette et al. provided very valuable results with respect to the present study. However, some aspects of their study could be considered as shortcomings. Apparently, the experiment was designed exclusively with verbs of motion. More precisely, authors gave examples of stories where only various verbs of motion were used: *"John was on a bike ride yesterday. After he sped / was speeding across the valley, he climbed / was climbing a mountain range. Then he pedaled / was pedaling along a river and finally, he coasted / was coasting into a campground."* [1]

Using motion verbs has a specific effect on our sensorimotor movements. The series of experiments on motion verbs showed their privileged position regarding the influence on our sensorimotor movements. (e.g. Matlock and Richardson 2004, Matlock 2010, Richardson and Matlock 2007, Spivey et al. 2000). In one of those studies, Matlock (2010) claims that the motion verb influences our conceptualisation to the extent that we simulate in our cognition the movement the language refers to. Evidence for the simulated motion are according to Matlock the eye movements which is argued to go in the direction of the actual movement.

In another study, Richardson and Matlock (2007) show that it is not even necessary to use a verb of motion in the meaning expressing actual movement. Also the so-called fictive motion verbs (e.g. *The road goes along the beach.*; see also Langacker 1986 and 2000 where this phenomenon is called "abstract motion" and Matsumoto 1996, where the term "subjective motion" is used) affect our conceptualisation and are probably simulated in our cognition. In the Richardson and Matlock (2007) study, the researchers showed participants pictures with a road lined with palms. They described to the participants what they see using either a fictive motion verb (*The road goes through the desert.*) or a neutral verb (*The road is in the desert.*) If the fictive motion verb was used, the participants scanned the path on the picture, arguably simulating the movement primed by the motion verb. If the researchers also added characteristics which made the path seem difficult to walk (e.g. *hilly, rocky*) the eye movements of the participants in the fictive motion verb condition were slower than when adjectives which make the path seem easy to walk on (e.g. plain, sandy) were used. In the case of the control condition with the neutral verb *to be* the researchers did not observe any significant differences in the speed of eye movements while using adjectives, suggesting how easy or difficult the path is to walk on. Those findings clearly suggest that motion verbs have a specific way of being processed and that the eye movements caused by motion verbs apply to visual rather than grammatical processing. That is why one could see the exclusive use of motion verbs as a shortcoming of the Huette et al. design, because motion verbs may have played a crucial role in revealing eye movements in participants.

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[1] Unfortunately, the link mentioned in the article where the supplementary materials could be found did not show anything more than was present in the article itself . I tried to contact the first author of the paper, Sandra Huette, via her correspondence email address stated in the article, but I did not get any answer.

In study by Huette et al., the authors did not consider any semantic constraints in the design of the experiment, like for example Vendler's (1967) verb types.

1.5 Research question and hypotheses

Because this study investigates the interplay of lexical and grammatical aspect, I base my predictions on studies concerning specific differences between eye movements revealed by all, perfective, imperfective aspect and telic and atelic situations expressed by verbs. From Huette et al (2014), the predictions regarding the grammatical aspect are distinctively shorter eye movements with wider dispersion in the case of imperfective aspect. This reasoning is based on studies which have shown a relationship between use of imperfective aspect and mere focus on dynamics, details of events and intensive mental simulation. (e.g. Anderson et al. 2008, Bergen and Wheeler 2010, Matlock et al. 2012, for overview see Huette et al. 2014).

As stated above, lexical aspect has received much less attention within cognitive experimental research. Nevertheless, taking into consideration that perfective aspect in English constrains mental conceptualisation to the endpoint of an event (Madden and Zwaan 2003), we can predict that the eye movements revealed by the situations with an intrinsic endpoint would be resemble those revealed by perfective aspect. Furthermore, Backer et al. (2013) show in their experiment that sentences describing situations with an endpoint, using a perfective verb, make processing easier than the combination of a telic situation and imperfective verbs. Yap et al. (2009) present findings in line with Backer et al. (2013) and add similar ones about easier processing of atelic events expressed by imperfective verbs.

The present study aims to investigate the link between the complex system of temporal cues and sensorimotor representation in Czech speakers, with a specific focus on the interaction between grammatical verb aspect and so called event telicity, i.e. lexical aspect.

The formulation of my research question is based on the rich overview of linguistic studies on lexical and grammatical aspect and psycholinguistic experiments which provide the evidence about how those two categories of verbs influence our representation: How are different combinations of lexical and grammatical aspect of Czech verbs reflected in eye movements?

In order to answer this question, I ran an eye tracking experiment using a blank screen paradigm (Altmann 2004). Eye movements of participants were measured while they were looking at a white screen, and listened to sets of three sentences in Czech, each employing one of the following aspectual conditions: (i) telic perfective (e.g. *Ráno jsem snědla$_{PF}$ chleba s máslem. 'I ate$_{PF}$ bread with butter in morning.'*), (ii) telic imperfective (e.g. *Ráno jsem jedla$_{IPF}$ chleba s máslem. 'I ate$_{IPF}$ bread with butter in the morning.'*) and (iii) atelic imperfective (e.g. *Celé ráno jsem jedla$_{IPF}$. 'I ate$_{IPF}$ the whole morning.'*). Previous research shows how described events with detailed spatiotemporal parameters involve sensorimotor systems of the brain. Thus, there is reason to believe that grammatical and lexical aspect affect a whole suite of different eye movements in a situation with no explicit visual task. As such, the proposed experimental paradigm mirrors real-world passive listening circumstances. This work aims to investigate the interaction of the lexico-semantic property of telicity and the morpho-syntactic property of verbal aspect. Therefore, my hypothesis is as follows:

(2)   Null Hypothesis: The three aspectual conditions yield eye movement measurements that do not differ from each other.

(3)   Alternative Hypotheses 1 and 2: The differences in eye movements between conditions (i) and (ii) (different grammatical aspect) are bigger (1)/smaller (2) than those between conditions (ii) and (iii) (different lexical aspect).

In other words, if the sentences that differ in terms of telicity reveal bigger differences in eye movements than the sentences that differ in terms of grammatical aspect, the property of lexical aspect would seem more tied to the engagement of sensorimotor systems than grammatical aspect in conceptualisation, and vice versa.

2. Methodology

2.1 Research question and hypotheses

Eight Czech speaking participants were measured and their eye movements were recorded with an eye tracking system SMI Red 500. The participants attended the experiment voluntarily, knowing in advance that they were not going to be rewarded for participation in the experiment. Five women and three men participated. All participants reported having normal or corrected-to-normal vision and no hearing problems or language deficiencies. Because the cognitive functions can become compromised by aging or not developed in early age (Glisky 2007), there is a need to have an age consistent group of participants. The age of the participants was between 21 to 28, which is in line with the research of Glisky. All participants reported to be studying or to have a university diploma.

2.2 Material

The sentences in a set were manipulated with respect to grammatical and lexical aspect. There were six sets of four sentences. Sentences within one set contained the same verb manipulated such that all of the following conditions were covered: (a) telic perfective, (b) telic imperfective, (c) atelic imperfective and (d) atelic perfective. Here are examples of the relevant types:

(4)   a. Ráno jsem snědla chleba s máslem.
          'I ate bread with butter in the morning.'
      b. Ráno jsem jedla chleba s máslem.
          'I ate bread with butter in the morning.'
      c. Celé včerejší ráno jsem něco jedla.
          I ate the whole yesterday's morning.
      d. Celé včerejší ráno jsem projedla.
          I ate through the whole yesterday's morning.

The formation of the atelic perfective verbs by means of the delimitative prefix *po-* is extremely productive process in Russian and quite productive in Bulgarian (Dickey and Janda 2015). This is not the case of Czech, where it is rather difficult to find such an example which would sound natural. In order to be able to manipulate the verb into an atelic perfec-

tive sentence, I used the prefix *pro-* which seems to have an analogical function in Czech, i.e. general perfectivizing prefix for atelic predicates, as the prefix po- in Bulgarian and Russian. However, atelic perfective predicates do not sound quite natural in Czech, which is why this condition was also excluded from the hypotheses formulation and was seen more as a filler for my experimental design.

For all the sentences used during the experiment see Appendix 1. The sentences were recorded by the same trained linguist (male, native speaker of Czech), with the normal dropping intonation used in Czech for declarative sentences.

2.3 Procedure

The data were recorded at 250Hz, which means that there were done 250 measurements of the ocular behaviour in one second. Participants were told to sit and read instructions on the screen. They were told to press the "proceed" button when they are explicitly asked to do so, otherwise the experiment proceeds itself. The participants were not told they are going to be investigated for a linguistic experiment. In order to confuse the participants about the purpose of the experiment and to avoid possible strategic or metalinguistic response leading from the awareness of the purposes of the experiment, a mock visual task was added to the experiment. Six pictures of different types of landscapes preceded every set of four recorded sentences. The participants were told to look at the landscapes carefully. They have been warned that after finishing the experiment, a series of questions about both the landscapes and auditory stimuli, will follow. Actually, no questions were asked at the end of the experiment, but this note was mentioned in order to be sure to get the participants to pay attention to the content of the experiment. Every picture of a landscape was carefully chosen so that it did not contain any objects in motion, or movement evoking objects (e.g. cars) and no paths. Every picture of landscape was displayed for 8000 ms.

Subsequently, the actual passive listening task followed. The task for the participants was to listen carefully to the following sentences, in order to forget the previous visual task. They were asked to keep looking at the screen to avoid recalibration. By this the illusion that the experiment was not a linguistic experiment was enhanced. Still, the participants were about to pay attention to the linguistic content because they expected some questions after the experiment on the auditory stimuli as well.

It is worth noting that because of the extent of this pilot study and the limited time to conduct an eye tracking experiment I decided to run just a within-participant experiment. Thus, all of the participants had heard all of the sentences. It is widely assumed that in experimental research it is necessary to run both the within and between-participants version of the experiment (for more see e.g. Stanovich and West 2008). However, as Huette et al. (2014) mentioned in their study, the situation for aspect is particular and this assumption is supported by three studies (Matlock 2010 2011, Fausey and Matlock 2011), where the between-subject experiments showed convergent results that were in line with the within-subject results.

The order of both, the auditory stimuli and the pictures was randomized by the experimental software for SMI red 500. Note that each trial always had the same order of appearance of the components and the same time the stimuli were presented to the participants. See picture 1 for illustration.

After each recorded sentence, the 5000 ms of silence was present. It was also the only time the eye movements relevant for present study were measured. Because the sentences were of different length, only the spontaneous offline processing was measured in the 5000 ms of silence following immediately after the end of each auditory stimulus.

3. Results

To compare ocular behaviour during the presentation of sentences with different grammatical and lexical aspect, the number of areas of fixation and average fixation duration were analysed. Analysing precisely those two features of eye movements goes also in line with predictions I based my hypotheses on. All the presented results pertain to eye movements that occurred after the end of the auditory stimuli.

Imperfective atelic sentences were followed by a relatively high number of fixations (11.7±SD), compared to imperfective telic sentences (6.7±SD) and perfective telic sentences (5.1±SD). Consequently, the average duration of individual fixations was lowest in the imperfective atelic condition (611±SD), followed by the imperfective telic (849±SDms) and perfective telic (988±SDms) conditions (Table 2). This constitutes a substantially bigger difference in eye movements between telic and atelic sentences compared to that between perfective and imperfective sentences.

	Fixation counts	Fixation duration (ms)
PF telic	5.1	987.5
IPF telic	6.8	848.9
IPF atelic	11.7	611.2

Table 2: Average fixation counts and average fixation duration.

4. Discussion

The results of the current study affirm the connection between eye movements and language processing, as established in previous literature. Specifically, the ocular behaviour here reported offers evidence for the notion that grammatical properties of processed text can be reflected in eye movements. Importantly, grammatical and lexical aspect can change the properties of situations expressed by verbs and as such cognitive experience. The results of my experiment align with much of the extensive psycholinguistic evidence on grammatical aspect. For example, Matlock et al. (2012) show that when participants were asked about details on a video recording by means of imperfective aspect ("What was happening?"), they spontaneously mentioned more action details and also performed more gestures than when prompted with a question in the perfect tense ("What happened?"). Whereas Matlock et al. infer the influence of grammatical aspect on conceptualisation from more extensive gestures and more detailed description of an action when retelling a story, the present study does so using a minimally constrained task.

Contrary to a wide range of studies on grammatical aspect, this study aimed to investigate how the interaction of grammatical and lexical aspect affects conceptualisation, as reflected in eye movements. Only a limited number of studies have focused on the interplay of these verb properties and to my knowledge, this pilot study is the first one focusing on Czech. The findings from Yap et al. (2009) and Becker et al. (2013) are partially conflicting. In the former, construction of mental representations of activities and accomplishments is

faster/easier when their inherent temporal properties and grammatical aspect match (imperf. activities, perf. accomplishments) rather than mismatch (perf. activities, imperf. accomplishments). To the contrary, EEG evidence from the latter study suggested that matching grammatical and lexical aspect does not make construction of mental representations of activities any easier. However, there was a discourse availability advantage for imperfective accomplishments over perfective ones.

The results of the current pilot experiment do not directly conflict with any of the above mentioned studies. Because it is difficult to find perfective atelic predicates that sound natural in Czech, we can only make comparisons with the part regarding the accomplishment verbs in Yap et al. (2009) and Becker et al. (2013). With respect to this, the current findings suggest the existence of a hierarchic structure of verb properties that, among others, shape cognition. Because average fixation durations were more similar between the conditions sharing the property of telicity, lexical aspect may be the more powerful feature of verbs regarding conceptualisation. The conditions in which lexical and grammatical aspect matched (telic perfective, atelic imperfective) were on the extremes of the spectrum regarding ocular behaviour. The conditions with mismatching grammatical and lexical aspect behaved like the "children" of the matching ones, carrying properties of both. Yet, the data show that telicity dominated the effects on ocular behaviour, suggesting a stronger role for lexical aspect than for grammatical aspect. This confirms my hypothesis that differences in eye movements between conditions with different grammatical aspect are smaller than those between conditions with different lexical aspect. In other words, the sentences that differ in terms of telicity reveal bigger differences in eye movements than the sentences that differ in terms of grammatical aspect. Thus, the property of lexical aspect seems to be more tied than grammatical aspect to the engagement of sensorimotor systems in conceptualisation.

It is worth pointing out that this is just a pilot study with a limited number of participants. Nevertheless, it may be the first evidence for a prominence of one of the tested verb properties over the other regarding conceptualisation. Continuing this line of research could be fruitful, because the current results, despite a limited sample of participants, revealed interesting facts about the reciprocal influence of grammatical and lexical aspect, and their interplay, on conceptualisation. Future research should focus on analogous experiments with broader samples, and more auditory stimuli. To ensure that the effect found in this study is not caused by the fact that participants somehow knew what the experiment was about, both within- and between-participant comparisons should be made.

This study also provides valuable information about the link between language and vision in contexts where no visual referents are available. Using parts of the methodology of Huette et al. (2013), this study continues the line of the research using the blank screen paradigm and as such provides data on the processing of pure linguistic material with arguably no or maximally limited biases produced by accompanying visual stimuli. This methodology also offers great value to research focused on the connections between brain areas that are crucial for language and those devoted to perception and motor systems.

More broadly, the results of this study may indicate a concrete embodiment of cognition on a lexico-semantic and morpho-syntactic level, in that different construals of the same reality can be "acted out" by eye movements differently. The results fit with theories of

cognitive linguistics and support the idea that grammar, as every part of the language, has detectable mappings from form to meaning and vice versa. This study supports the idea that language and all its parts consist of three basic components (structure, meaning and function) which influence each other and reflect our cognition. It shows that morphosyntactic and lexico-semantic properties of verbs influence our mental representation in a measurable way. This leads one to wonder if parts of language systems such as grammar or semantic types of verbs, which were considered to be abstract, may be a more concrete player in perception than previously thought.

Furthermore, this experiment is novel because it investigated a West Slavic language, Czech. Most studies which have been carried out on this topic with comparable methodology were about English. Aspect in English behaves differently than in Czech, in which grammatical aspect is obligatorily indicated with morphological markers (prefixes or suffixes). Therefore, the current study offers new insight on the psycholinguistic reality of grammatical and lexical aspect in West Slavic languages and as such can be used as valuable cross-linguistic material for comparisons with the behaviour of aspect in other Slavic languages.

Finally, this study can, thanks to its broad survey of secondary literature, serve as a solid overview on the experimental approach on both grammatical and lexical aspect.

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