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Facing salient and non-salient time sequence orientation types expressed by adverbs in English, Mandarin and Serbian

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Abstract: This article intends to provide insight into how speakers of English, Mandarin, and Serbian perceive spatio-temporal relations expressed by specific pairs of adverbials. In two studies participants were presented with simple sentences describing the metaphorical movement of events on the timeline (e.g., "The meeting was moved from the morning to the afternoon.") and were asked to decide whether the event had been moved along the sagittal, vertical or transverse axis (forward/backward, up/down, left/right). The main aim of the first study, which was conducted with 104 native speakers of Serbian, was to explore the effects of axis-orientation and individual time units on participants' preferences and response times. The target time units used were dates, hours, months, days of the week, and years. The results showed significant differences in response times between the transverse and sagittal axis conditions on the one hand (with shorter reaction times), and the vertical axis condition on the other. Moreover, the distribution of answers showed a high degree of inconsistency when it came to moving events to a previous point in time. The main aim of the second study was to identify potential differences in responses and response times to different orientations and time units between four experimental groups: native speakers of English with no second language, native speakers of English with knowledge of a second language, native speakers of Mandarin (with English as a second language), and native speakers of Serbian (also with English as a second language). The study was conducted with 126 participants. The design of the

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second study was largely parallel to that of the first, but it involved three trials and different time units (parts of the day, days of the week and months). The Mandarin speakers gave the quickest responses in the first two trials when deciding on the vertical axis. Moreover, reaction times were significantly shorter in the parts-of-the-day condition (e.g., "morning", "afternoon"), across the three trials. In addition, Mandarin speakers showed an inverted trend in responses on the sagittal axis compared to the remaining three groups. While some of our results corroborate previous research on the topic, the study also provides novel empirical evidence on how Serbian speakers conceptualize time using spatial terms.

Keywords: metaphor; space–time relations; spatial adverbs; spatial axis; time units

1 Introduction

Interaction of the domains of space and time, and the idea of understanding the concept of time as a function of the more graspable domain of space has attracted a lot of attention in cognitive sciences, mostly in the field of frames of reference (e.g., Bender and Beller 2014), conceptual metaphor theory (e.g., Boroditsky 2000; Gentner and Imai 1992; Lakoff and Johnson 1980), as well as in the domain of the theory of magnitude (e.g., Bueti and Walsh 2009; Magnani and Musetti 2017). Evidence from a range of languages around the globe suggests that people use spatial vocabulary and concepts to talk about time (e.g., Alverson 1994; Bender and Beller 2014; Clark 1973; Haspelmath 1997). So, for instance, postponing events is typically understood as moving forward (along the sagittal axis) or rightward (along the transverse axis). There is greater inter-participant agreement within languages for the vertical and transverse axes compared with the sagittal axis, with the transverse axis showing major differences between languages (e.g., Bender and Beller 2014; Bender et al. 2010; Boroditsky 2001; Fuhrman et al. 2011; Hegarty and Stull 2012; Kövecses 2002; Torralbo et al. 2006; Tversky et al. 1991; Yu 1998). Building on the results of the previous research in the field, the present article explores participants' preferences regarding salient and non-salient 'movement' of events along the timeline in terms of recorded response times (RTs) and their characterization of the identified 'movements'. The types of movement we tested had different levels of salience (or non-salience) in different languages and cultures. The approach included two studies, both of which involved a version of the event moving task (previously used in several studies, including Bender et al. 2010; McGlone and Harding 1998; Rothe-Wulf et al. 2015).

The main aim of the first study was to identify possible differences in participants' RTs in relation to the 'movement' of events along the three aforementioned axes and to examine the structure of their preferences, so as to relate the obtained results to the previous corpus-based and theoretical work in the field concerning the Serbian language (Klikovac 2000, 2004; Rasulić 2004). It included only native speakers of Serbian who were presented with the stimuli sentences and asked to decide whether the target event had been moved backward/forward, leftward/rightward, or upward/downward. The target time units included dates, hours, months, days of the week, and years, and the study involved a single trial. The main task in the second study was similar to the one employed in the first, and its primary goal was the exploration of possible differences in RTs and responses themselves for the three types of orientation, between four groups of respondents, including the observation of potential cross-cultural and language-related differences between the native speakers of English, Mandarin and Serbian. It included the following four groups of respondents: (i) native speakers of English (only), (ii) native speakers of Mandarin (with English as their second language), (iii) native speakers of Serbian (with English as their second language), and (iv) those who spoke English and another language. The study involved three trials, and the target time units included parts of the day, days of the week, and months. Specific research questions concerning each of the two studies, formulated in line with the main aims, are outlined in Sections 3.1 and 3.2 below.

The article is organized as follows. After the introduction, we present an overview of the theoretical framework and relevant research in the field. This is followed by the description of the design and empirical procedures involved in the two main studies, after which we present the main results obtained in the studies. Finally, we move on to the general discussion of the findings, and outline some of the main conclusions and implications for future research.

2 Theoretical framework – space, time, thought and language

In order to deal with the complex domain of temporal information, our minds resort to a more graspable notion of space. The fact that space, although complex as well, is more graspable might be attributed to the fact that spatial concepts are acquired before processing non-spatial information (see Mandler 2006). The domains of space and time are related to such an extent that there have been claims that there is virtually no way of experiencing them separately (Kronasser 1968). Naturally, spatio-temporal relations have had their reflections on languages

around the globe and many of them have been studied in regard to this phenomenon, with said relations mainly characterized as metaphorical (e.g., Alverson 1994; Boroditsky 2000, 2001; Haspelmath 1997; Lewandowska-Tomaszczyk 2016; Nuñez and Sweetser 2006; Torralbo et al. 2006; see Bender and Beller 2014 for a comprehensive overview). Studies reporting languages in which time and space do not seem to be bound are quite rare (e.g., Sinha et al. 2016), though such languages do exist, which is why some scholars claim that the notion of metric time is not universal, but a cultural and historical construction (Sinha and Gärdenfors 2014). Time is, in fact, only one of the several semantic domains shaped by the elements coming from the realm of space, location, and motion (Jackendoff 1983). This list includes those concepts that cannot be easily perceived – upon encountering such concepts, our mind does not start the process of conceptualization from scratch, it rather relates to the existing spatial concepts and adapts them to fit the new requirements. Thus, we organize our conceptual structure using a limited set of principles, many of which have spatial foundations (Jackendoff 1983; Tversky 2019).

In neurosciences, we find studies that not only agree with such a view, but also empirically confirm the idea that our brains understand the time dimension by means of a spatial code (Bueti and Walsh 2009; Magnani and Musetti 2017; Oliveri et al. 2009; Walsh 2003). These studies largely belong to *A Theory of Magnitude* (ATOM) movement, in which quantities (including space, time, numerals, auditory signals) rely upon a generalized innate magnitude system that computes representations such as 'smaller-bigger', 'slower-faster', 'nearer-farther', etc. Linearity and ordinality of number cognition necessary for the spatial representation of time emerge after the age of five, while the spatial meanings of time concepts become available between the age of eight and ten (Magnani and Musetti 2017).

In cognitive linguistics, spatio-temporal relations have mostly been dealt with within conceptual metaphor theory (e.g., Boroditsky 2000; Casasanto and Boroditsky 2008; Gentner and Imai 1992; Kövecses 2002; Lakoff and Johnson 1980; Weger and Pratt 2008; Yu 1998; and in Serbian in; Klikovac 2000, 2004; Rasulić 2004) and they are most frequently related to the TIME IS SPACE and TIME IS MOTION IN SPACE conceptual metaphors. Spatio-temporal relations are frequently viewed within the moving perspectives approach in which they are related to two dominant metaphors, the EGO-MOVING and the TIME-MOVING METAPHOR, which have been studied in various approaches (Alloway et al. 2001; Alverson 1994; Clark 1973; Fillmore 1971; McGlone and Harding 1998; Traugott 1978). In the former metaphor, the human entity is moving through time (as in *We are approaching the end of the year*), while the latter implies that the human is a static viewer and time is a moving entity (as in *Christmas is coming soon*). The existence of these two systems of time

comprehension might even cause confusion, especially when we try to decide whether something has traveled forwards or backwards in time. Cognitive linguists would usually treat spatio-temporal relations as systematic and asymmetric – i.e., claim that temporal relations would be described using spatial ones, not vice versa (e.g., Bottini and Casasanto 2010), while some later studies indicate that a certain degree of reversibility is possible (e.g., Cai and Connell 2015). Most authors within the CMT framework equate these relations with mappings between domains (for a recent discussion of the status of mappings in metaphor comprehension see Holyoak and Stamenković 2018 and Stamenković et al. 2019). The fact that the domain of time (just like many abstract domains) depends so much on the domain of space may even cast doubt upon the assumption that the relation between the two is metaphorical – it might belong to a more basic set of patterns that should not be called metaphor at all (see Tversky 2019). However, there is no way to deny that these relations exist.

Empirical evidence pertaining to spatio-temporal relations has been presented for a range of languages, including English, German, Swedish, Spanish, Hebrew, Arabic, Mandarin and Tongan (see Bender and Beller 2014 for an overview). Even though to the best of our knowledge, there are no empirical studies on spatio-temporal relations in Serbian, the conducted theoretical and corpus-based research indicates that time is conceptualized in Serbian primarily as movement and that the TIME IS SPACE metaphor only serves as a concretization of the general notion of such movement (Klikovac 2000: 147). Here, timelines are also observed predominantly as straight lines along the sagittal axis, with the future in front of us and the past behind, and time is represented as a linear motion forward, e.g., *Približavamo se kraju godine* [*We are approaching the end of the year*] (Klikovac 2000: 147). In addition, time units can also travel downward, along the vertical axis, with each previous unit positioned below the next one (Klikovac 2004: 247), in the sense that time is conceptualized as matter that accumulates on the bottom, where older events are further away from us than more recent ones, e.g., *Uprkos svim slojevima vremena naslaganim u proteklih trinaest godina* [*In spite of all layers of time accumulated in the past thirteen years*] (Klikovac 2000: 157). Rasulić (2004: 310) elaborates on the vertical orientation, in which the future is up and the past down, by drawing particular attention to a specific manifestation of this conceptualization found in the Serbian language, where the end of a period or a cycle is up and that which precedes it is down, e.g., *Samo pod kraj leta nebo je tako nisko* [*Only *below the end of the summer is the sky so low*]. We can see that the above-described orientation is retained in this latter case, with older time units or "layers" positioned below the more recent ones, despite the fact that the flow of time is now observed from an external perspective as moving upward. This apparent contradiction stems from the different reference points from which the flow of time is

perceived. On the one hand, if time is conceptualized as a moving object (Lakoff and Johnson 1980: 42 – the Moving Time perspective), then it travels towards us and past us, in this case from the space above to the space below; on the other, if we are the ones moving through stationary time (Lakoff and Johnson 1980: 43 – or the Moving Ego perspective), then it appears as if we are traveling upward facing the future that is above us. Either way, the vertical orientation in Serbian in which the future is up and the past is down remains unchanged. These corpus-based findings, particularly the ones related to the sagittal axis, are further corroborated by cases in which time or time units metonymically serve as containers for specific events, e.g., *Iza mene je jedna teška godina* [*A difficult year is behind me*] (Ćirić 2016: 80). To sum up, based on the examples found in the existing literature, the representation of time in Serbian mostly corresponds to its counterpart in English.

Another comprehensive overview of spatio-temporal relations was given within the domain of *frames of reference* (*FoRs*) by Bender and Beller (2014), in which they provide a scaffolding that integrates a range of previous approaches. The authors use the results from around thirty studies and systematize them into eight different accounts for using spatial frames of reference for temporal setups. The *frames of reference* were originally spatial and provided coordinate systems which allowed us to establish the position of a figure in reference to a ground from a certain perspective (Talmy 2000). For instance, in Levinson's (2003) proposal, the absolute frame of reference would include the four sides of the world, and the intrinsic and relative spatial frames of reference would involve terms such as left, right, front, and back (but the viewpoint of the observer in the relative frame would be external); by using these frames we are able to determine the position of the figure in relation to the ground. Bender and Beller (2014) use Levinson's principles to set up *temporal frames of reference* and provide a framework that could account for the cross-linguistic variability in spatial references used to portray temporal events, noting any potential preferences of different language groups. Such a setup has allowed them to evaluate the degree of space-time mapping and to foreground evidence for preferred spatial and temporal frames of reference based on a set of studies (including their own).

When it comes to the spatial properties of timelines related to spatio-temporal relations, they are mostly related to straight lines (see Rosenberg and Grafton 2010), and although languages explicitly use the sagittal (front/back) and the vertical (up/down) axis, the transverse (left/right) axis is also employed (Hegarty and Stull 2012; Pagán Cánovas and Valenzuela 2017). The orientation or direction of the mental timeline has mostly been studied in regard to the latter axis – in the Western world it is usually oriented from left to right (e.g., Torralbo et al. 2006; Tversky et al. 1991; Weger and Pratt 2008); in mainland China Mandarin is written left to right and then top to bottom, while in Taiwan it is more likely to be written

from top to bottom, and this affects their spatial representation of time (Bergen and Chan Lau 2012). Thus, the orientation mainly corresponds to the writing system (see Athanasopoulos et al. 2017; Bottini and Casasanto 2010), although there are those who oppose this view (see Ouellet et al. 2010). Along with the explorations of the horizontal axis, a body of work was dedicated to the vertical orientation as well (e.g., Boroditsky 2001; Boroditsky et al. 2011; Fuhrman et al. 2011; He et al. 2018; Hong et al. 2017). The reasons that are responsible for the similarities and differences in spatial, and in turn temporal, representations depend on a range of factors, which can include gravitation (up and down), the anatomy of the human body (front and back), cultural values (left and right), cultural conventions and patterns (Bender and Beller 2014).

The issue of timeline orientation initiated one of the most intriguing debates in cognitive linguistics (summarized in Stamenković 2018) – the discussion of whether different spatio-temporal configurations in languages lead towards a different conceptualization of time or not, i.e., whether the results of the studies of spatiotemporality can be used to support the revival of the Sapir–Whorf hypothesis (e.g., Whorf 1956). In particular, a study by Boroditsky (2001) employed a spatial (horizontal and vertical) priming procedure and compared native speakers of English with English-Mandarin bilinguals in a set of tasks that involved spatial and temporal questions. Boroditsky reported that native English speakers answered time questions faster after the horizontal primes than after the vertical ones, whereas Mandarin speakers answered equally quickly in both cases. Besides this, Boroditsky noted that, unlike the speakers of English, Mandarin-English bilinguals solved purely temporal targets faster after the vertical primes as compared to the horizontal primes. Because of this, Boroditsky concluded that one group of speakers thought about language horizontally, and the other vertically, which she linked to the claim of language being a tool in shaping habitual thought about abstract domains. Different spatial metaphors that can be found in English and Mandarin were understood as causing important differences in the way the two groups thought about time. Moreover, the procedure used in the third study of the 2001 article caused additional controversy in the years to follow. Namely, in the study, the English speakers were trained in a 'new way to talk about time' by receiving 90 examples of sentences making use of the vertical metaphor for time found in Mandarin (e.g., *Bill Clinton was president below Ronald Reagan*). After the training process that lasted roughly 15–20 min, the subjects managed to completely reverse their response pattern, as they seemed to have taken on a new way of thinking about time.

Boroditsky's approach has prompted criticism from several directions. Namely, Gleitman and Papafragou (2012 [2005]) were not convinced that the results yielded in Boroditsky's empirical procedures reflected any substantial

differences in time conceptualization in English and Mandarin speakers. The fact that speakers of one language can very easily adapt to a new timeline type, in fact, indicates that we are likely to be talking about subtle differences between languages. In that case, if 15 min of training are enough to shift one's perception of time acquired over the span of 20 or more years, we cannot claim that these groups were thinking about time that differently at all. Gleitman and Papafragou maintain that the immediate effects of metaphorical expressions coming from these two languages are transient and are not able to affect one's conceptualization of time in the way in which Boroditsky claimed it happened. Furthermore, given the example *This recipe came down to me from my grandmother*, we cannot say that vertical time metaphors are completely absent from English. Although Gleitman and Papafragou are right in their conclusions that the claim that we are *thinking* about time differently is too strong and that these differences are subtler than it seems, they still exist and are worth exploring. Apart from this theoretical piece of criticism, there have been several empirical assessments of Boroditsky's results. January and Kako (2007) report six failed attempts at replicating Boroditsky's procedures. They even report that the English speakers in their empirical procedures were slower in responding after being primed horizontally and that in purely temporal expressions they were under a greater influence of vertical primes. Similarly, Chen (2007) describes four failed attempts to replicate the original studies reported by Boroditsky. Chen notes that Mandarin speakers in fact use horizontal time metaphors much more frequently than vertical ones. The effect that Boroditsky achieved is only possible when different time units are lumped together, but not when they are treated separately. Chen even notes that some of her results were completely contrary to Boroditsky's claims. Likewise, Tse and Altarriba (2008) had no luck replicating Boroditsky's results – they found that vertical primes were more efficient in the case of their English participants when it comes to purely temporal tasks. Both the English and the Mandarin participants were overall faster after being vertically primed, which indicated that the participants' conceptualization of time was not determined by their native language.

In their subsequent studies related to this issue, Boroditsky and her associates (e.g., Boroditsky et al. 2011; Fuhrman et al. 2011) did not fully give up on the original ideas or conclusions, although they changed their initial claim that implied a categorical bias between the horizontal and the vertical dimension in Mandarin to "a revised and weaker version" in which "Mandarin speakers are more likely to conceive of time vertically than English speakers" (Chen and O'Seaghdha 2013: 341). Accepting that there had been flaws in the original study set-up, they attempted to resolve them by changing the empirical design, so that the visual stimuli started replacing the verbal ones. The new studies were reported as being consistent with the hypothesis that language has an impact on the way in which we

conceptualize time. All this makes spatio-temporal differences between speakers of English and Mandarin still very relevant in terms of assessment.

3 Overview of the present approach

To the best of our knowledge, there have been no participant-based empirical studies exploring spatio-temporal relations in the Serbian language. Moreover, the existing summary articles (the most comprehensive of which is Bender and Beller 2014) do not involve studies assessing any other Slavic language. Given this, we aimed at providing an initial step towards testing the corpus-based conclusions coming from the studies we mentioned in the previous section (Klikovac 2000, 2004; Rasulić 2004). In the second step, we wanted to compare Serbian to the pair of languages whose spatio-temporal properties have been most frequently studied (English and Mandarin), employing an improved version of the design we used in the first step. This provided us with the rationale behind our selection of languages. So, within this article, we present two studies that involved a psycholinguistic approach to evaluate the participants' responses to a set of salient and non-salient time sequence orientations in English, Mandarin, and Serbian. We did this by presenting them with simple sentences describing the metaphorical movement of events from one point on a timeline to another, and asking them whether the move brought the event *backward*/*forward* (related to the sagittal axis), *upward*/*downward* (related to the vertical axis), or *leftward*/*rightward* (related to the transverse axis). These two studies involved native speakers of Serbian, English and Mandarin, and similar procedures, which are going to be described within the next two sections. Also, in the following sections, we outline the main aims and research questions pertaining to each of the two studies.

3.1 Study 1

In the first study, we used a single-trial procedure involving the three adverbial pairs mentioned above (*backward*/*forward*, *upward*/*downward*, or *leftward*/*rightward*) with a population of Serbian undergraduate students. The main aim of the first study was to determine whether there would be any significant differences in participants' RTs in relation to the three main types of orientation. One of the main aims of the first study was to explore how the three main types of orientation (left-right, up-down, and backward-forward), and the selected individual time units (years, months, dates, days, and hours) would affect the participants' response times and preferences. Also, the study was designed to facilitate the comparison of the data available from previous

research dealing with the spatial conceptualizations of time in Serbian, on the one hand, and the empirical data afforded by the present experiment, on the other. In line with the main aims, the first study will attempt to provide answers to the following four research questions: (1) Will there be any significant differences in the recorded overall lumped mean RTs between the three main types of orientation – left-right, up-down, and backward-forward? (2) Will there be any significant differences in the recorded mean RTs between the three main types of orientation (i.e., left-right, up-down, and backward-forward) for each individual time unit (i.e., years, months, dates, days, and hours)? (3) How consistent will the participants' responses be in the conditions of (i) postponing and (ii) moving to a previous point (we will be using the term *advancing*), in relation to the orientation along the three mains axes (i.e., the horizontal, vertical, and sagittal axis)? (4) How will the obtained empirical data relate to the previous theoretical research in the domain of spatio-temporal relations in the Serbian language?

3.1.1 Participants

A total of 104 undergraduates at the Faculty of Philosophy (57) and Faculty of Mechanical Engineering (47), University of Niš (female = 53, male = 51; mean age = 20.9, SD = 1), participated in the study. All of them were native speakers of Serbian. The data coming from an additional participant were dropped from analyses, as their native language was not Serbian.

3.1.2 Design, materials, and procedure

The empirical procedure was designed in *OpenSesame* (Mathôt et al. 2012) and run on a standard PC configuration. The language of the entire procedure was Serbian. After receiving the instructions and providing the basic anonymized demographic data, the participants completed a single trial in which we presented a total of 60 similar tasks. In each task, they first saw a sentence saying "The meeting was moved from (time unit 1) to (time unit 2)" in Serbian (e.g., *The meeting was moved from June to September; The meeting was moved from 3 pm to 12 pm; The meeting was moved from September to October*). This was followed by a task saying "The meeting was moved: option 1 (leftward/upward/backward) | option 2 (rightward/downward/forward)," with one button designated for each response. The time units in the stimulus sentences involved dates, hours, months, days of the week, and years (12 of each), and within each time unit one half of the shifts happened towards the past, and the other towards the future. The grammaticality of all sentences was confirmed with two native speakers of Serbian. Due to the horizontal layout of the keyboard, options 1 and 2 were presented one above the other

on the screen (i.e., they were aligned vertically). We did this in order to mitigate a potential horizontal or vertical bias. The order of presentation of sentences for each participant was randomized, and by doing this we prevented any possible effects of the order of presentation on the results. We recorded both the response (the participants' preference) and the response time.

The participants received the following instructions: "You will be presented with various sentences that refer to moving a meeting from one time to another. If the sentence refers to days of the week, they all belong to the same week, if it refers to months, they all belong to the same year, etc. Your task is to decide whether the meeting was moved leftward, rightward, upward, downward, forward or backward. Please respond as quickly as possible and in line with your intuition – there are no right or wrong answers." The sessions lasted around 10 min.

3.1.3 Results

The first step in the analysis was directed at checking the differences in response times when it comes to the three types of orientation we explored. The mean lumped RTs for each of the three main types of orientation are presented in Figure 1.

One-way repeated measures ANOVA showed a significant effect of the type of orientation, with Wilks' Lambda = 0.77, $F(2,91) = 13.94$, $p < 0.001$, and multivariate partial eta squared = 0.23. Subsequent pairwise comparisons revealed significantly faster RTs recorded in the leftward/rightward condition (M = 3,574.57 ms,

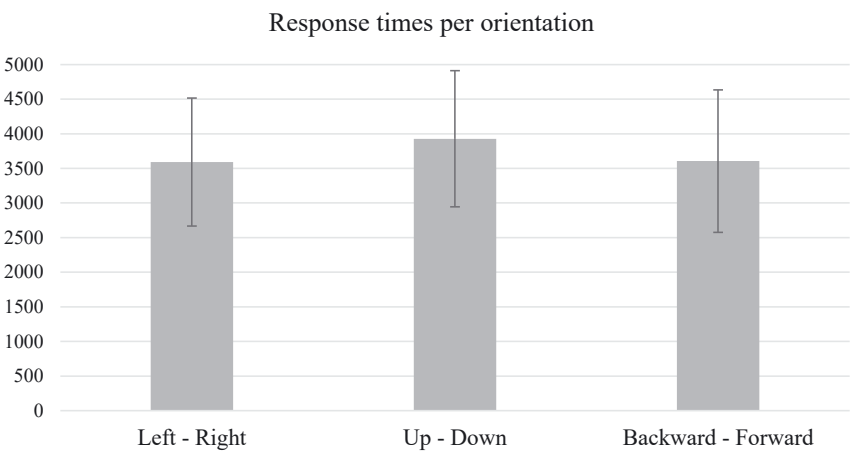

Figure 1: Representation of response times (in ms) per type of orientation.

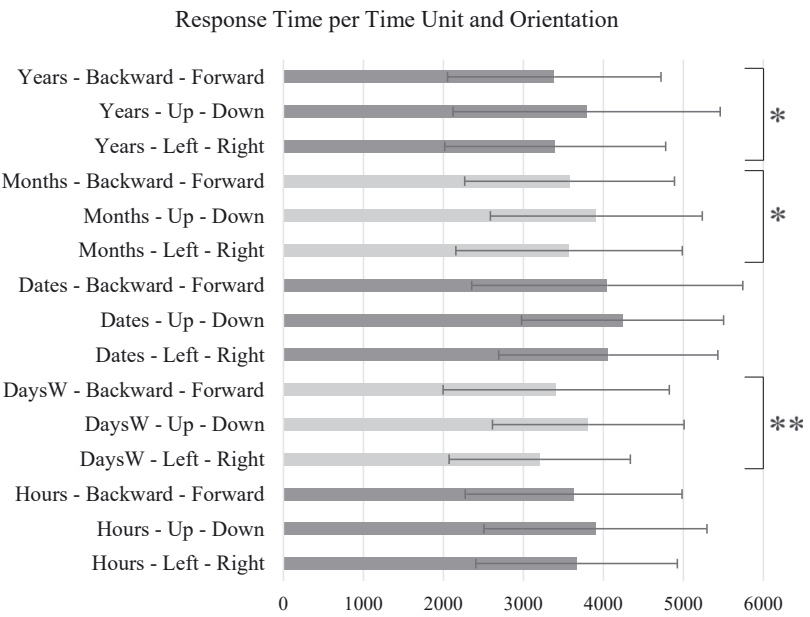

Figure 2: Mean response times (in ms) per type of orientation and time unit used.

SD = 952.67 ms, $p < 0.001$) and the backward/forward condition (M = 3,595.59 ms, SD = 1,030.14 ms, $p < 0.001$), compared to the upward/downward condition (M = 3,904.11 ms, SD = 977.94 ms). Comparison of the leftward/rightward and backward/forward conditions did not yield significance ($p > 0.5$).

Given the differences in scores reported by the previous studies for cases when various time units are lumped together as opposed to being treated separately, we decided to examine the means of these three orientations per time unit we used. The mean response times are presented in Figure 2.

In a way similar to the one in which we presented the lumped scores, one-way repeated measures ANOVA was conducted for each of these five groups. In the case of *months*, the main effect of orientation was significant (Wilks' Lambda = 0.9, $F(2,99) = 5.44$, $p = 0.01$, multivariate partial eta squared = 0.10), and subsequent pairwise comparisons showed significantly faster RTs in the leftward/rightward (M = 3,532.80 ms, SD = 1,368.60 ms, $p = 0.02$) and backward/forward condition (M = 3,547.08 ms, SD = 1,277.77 ms, $p = 0.02$), compared to the upward/downward condition (M = 3,907.62 ms, SD = 1,329.68). A similar trend was identified for *days*, where the main effect of orientation was also significant (Wilks' Lambda = 0.84, $F(2,98) = 9.59$, $p < 0.001$, multivariate partial eta squared = 0.16). Furthermore, the recorded RTs were significantly faster in the leftward/rightward (M = 3,204.78 ms,

SD = 1,132.93 ms, $p < 0.001$) and backward/forward condition (M = 3,419.53 ms, SD = 1,412.83 ms, $p = 0.03$), compared to the upward/downward condition (M = 3,812.28 ms, SD = 1,198.98 ms). In the case of *years*, the main effect of orientation was again significant (Wilks' Lambda = 0.93, $F(2,101) = 3.60$, $p = 0.03$, multivariate partial eta squared = 0.07); however, pairwise comparisons revealed a significant difference in RTs only between the backward/forward condition (M = 3,387.10 ms, SD = 1,335.63 ms, $p = 0.04$) and the upward/downward condition (M = 3,787.95 ms, SD = 1,678.53 ms). *Dates* and *hours* did not show a significant main effect of orientation ($p > 0.5$). Overall, it can be concluded that the pattern of differences followed the one we described for all tasks (leftward/rightward and backward/forward having mostly similar values and upward/downward differing from these two).

We also ran an additional repeated measures ANOVA to compare the mean RTs per time unit for each of the three types of orientation. A significant main effect of orientation was identified in the leftward/rightward condition (Wilks' Lambda = 0.73, $F(4,94) = 8.85$, $p < 0.001$, multivariate partial eta squared = 0.27). Pairwise comparisons showed significantly faster RTs between *months* (M = 3,590.31 ms, SD = 1,424.27 ms, $p = 0.01$), *days* (M = 3,238.48 ms, SD = 1,130.02 ms, $p < 0.001$), and *years* (M = 3,403.85 ms, SD = 1,387.62 ms, $p < 0.001$) on the one hand, and *dates* on the other (M = 4,072.07 ms, SD = 1,360.81 ms). Orientation also showed significance in the backward/forward condition (Wilks' Lambda = 0.87, $F(4,95) = 3.65$, $p = 0.01$, multivariate partial eta squared = 0.13), while pairwise comparisons showed significantly faster RTs for *days* (M = 3,425.02 ms, SD = 1,421.25 ms, $p = 0.02$) and *years* (M = 3,410.06 ms, SD = 1,342.38 ms, $p = 0.01$), compared to *dates* (M = 3,944.03 ms, SD = 1,603.35 ms). Finally, a significant main effect of orientation was also identified in the upward/downward/condition (Wilks' Lambda = 0.87, $F(4,98) = 3.56$, $p = 0.01$, multivariate partial eta squared = 0.13). The only significant difference in RTs revealed by the subsequent pairwise comparisons was between *days* (M = 3,800.24 ms, SD = 1,204.26 ms, $p = 0.02$) and *dates* (M = 4,239.72 ms, SD = 1347 ms).

The presented results show that the participants had the most difficulties in the case of dates compared with the remaining time units. Although pairwise comparisons did not reveal significant differences in all cases, the recorded RTs for dates were consistently slower for all three types of orientation and compared to all the remaining time units (i.e. hours, months, days, and years). Moreover, pairwise comparisons did not reveal any significant differences between any of the remaining time units. It also bears repeating that the obtained results show an overall delay in the upward/downward/condition compared to the leftward/rightward and backward/forward conditions and the difference also reached significance.

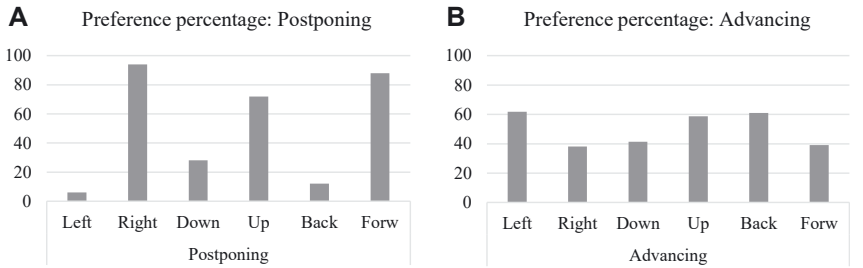

Figure 3: Percentage stats on directions preference for each orientation condition.

The following analysis investigated the participants' consistency regarding their choices when it comes to the direction of moving events towards the future, i.e., postponing, or towards the past, i.e., moving an event to an earlier point in time (advancing). The former (postponing) exhibited rather consistent results with both the leftward/rightward and the backward/forward pair, where postponing was largely associated with the rightward and the forward directions. Advancing was inconsistent in all conditions, but still, it was mostly associated with the leftward and the backward directions. This can be seen in Figure 3.

The vertical orientation indeed seemed more puzzling in regard to the participants' preference concerning the direction. Namely, it is not only that in postponing the choice of the direction was less consistent as compared to the remaining two axes, but the upward responses were more common than downward responses in both the postponing and the advancing contexts, which reflects the overall puzzledness with this timeline.

3.1.4 Discussion

Before moving on to the second study, we will briefly summarize the obtained results and offer answers to the main research questions that the first study dealt with.

(1) Type of orientation exhibited a significant main effect, while pairwise comparisons showed significantly faster overall mean response times in the upward–downward condition compared to both of the remaining two conditions. Left–right and backward–forward conditions did not reveal any significant differences. The obtained results may be accounted for by the fact that the conceptualization of time in Serbian is far more common along the sagittal and

transverse axis compared to the vertical axis; in effect, the former two axes afforded faster responses.

(2) The analysis of individual time units revealed a significant main effect of orientation in the case of months, days, and years. Dates and hours, on the other hand, did not yield significance; however, the upward–downward orientation again showed higher mean RTs compared to the remaining two types of orientation. Overall, the tendency identified for the lumped overall mean RTs was predominantly replicated for individual time units. It is also worth noting once again that *dates* seem to have caused the most difficulties for the participants, judging by the comparison of the recorded mean RTs with the remaining time units.

(3) The data suggest that the postponing condition showed significantly more consistent results, insofar as the dominant percentage of responses was 'right' (along the transverse axis), 'forward' (along the sagittal axis), and 'up' (along the vertical axis). However, around 30% of responses along the vertical axis were 'down', showing a lower degree of agreement compared to the other two axes. Contrary to this, the condition of advancing showed a lower degree of agreement between participants. Namely, there were approximately 60% of 'left', compared to 40% of 'right' answers for the transverse axis. A similar distribution of responses was identified along the sagittal axis, with the higher percentage of 'back' responses. Finally, there was a higher percentage of 'up' responses for the vertical orientation, but the ratio was smaller compared to the other two conditions (see Figure 3 for details). Consequently, it can be argued that the condition of advancing affords much less consistent conceptualizations along all three axes.

(4) When it comes to comparing the results to the corpus-based research, we can say that our results corroborate the presence of the sagittal axis in conceptualizing time expressed in Serbian. However, the present approach does not find evidence that speakers of Serbian are too used to time units that can also travel downward, along the vertical axis, as the responses related to this particular axis were significantly slower when compared to the sagittal axis (which is mentioned in the corpus-based account) and the transverse axis (which is not common in spoken language but can be related to depicting the passage of time in the direction of writing in Serbian, from left to right). Based on the postponing items, which exhibited some consistency, a meeting moving towards the future was seen as traveling up, something also accounted for in the studies in Serbian referenced above.

3.2 Study 2

In the second study, we decided to use a design with three trials in order to be able to track the adaptation period to unusual orientations/axes. Moreover, the study involved four groups of participants – speakers of English (only), native speakers of Mandarin (who spoke English as their second language but were not native speakers of English), native speakers of Serbian (who spoke English as their second language but were not native speakers of English), and those who spoke English and another language. The procedure also involved the three adverbial pairs (*backward*/*forward*, *upward*/*downward*, or *leftward*/*rightward*) given in Serbian, English, or Mandarin.

3.2.1 Participants

A total of 126 undergraduates participated in the study (female = 81; male = 43; undeclared = 2; mean age = 20.6): 93 of them were students at the University of California, Los Angeles, while the remaining 33 students studied at the Faculty of Philosophy, University of Niš. Their structure in terms of language spoken included the following four language groups: (i) 39 of them were native speakers of English who spoke no other language fluently, (ii) 29 of them were Mandarin speakers, (iii) 25 students spoke English and another language fluently (including Spanish, Italian, Korean, Hungarian, Hebrew, but excluding Mandarin or Serbian), and (iv) the remaining 33 respondents were native speakers of Serbian.

The main aim of the second study was to explore possible differences in response times and responses for the three main types of orientation, between the four experimental groups described above. The study was also designed to explore potential differences between the native speakers of the three examined languages and compare the obtained findings with the relevant previous research in the field. In effect, the second study was designed to provide answers to the following specific research questions: (1) Will there be any significant differences between the four experimental groups in the recorded overall lumped mean RTs for the three main types of orientation – left–right, up–down, and backward–forward? (2) Will there be any significant differences between the four experimental groups in the recorded mean RTs between the three main types of orientation (i.e., left–right, up–down, and backward–forward) for each individual time unit (i.e., parts of the day, days, and months)? (3) How consistent will the responses in each experimental group be in the conditions of (i) postponing and (ii) advancing, in relation to the orientation along the three main axes (i.e., the transverse, vertical, and sagittal axis)? (4) How will the obtained empirical data relate to the previous

research in the domain of spatio-temporal relations in the English, Mandarin, and Serbian language?

3.2.2 Design, materials, and procedure

The empirical procedure was designed in *SuperLab 5*, run on standard PC or Apple configurations, and it largely mirrored the one used in Study 1, but there were some differences. Namely, the language of the entire procedure was English, Mandarin, or Serbian, depending on the group (the group of native Mandarin speakers did the testing in Mandarin, native speakers of Serbian did it in Serbian, while the remaining two groups were tested using the English variant). All versions of the study were adapted by native speakers of the three languages. After the adaptation, the grammaticality of all sentences was confirmed with two native speakers of each language. Time units were changed: in this study, we used parts of the day (that were not used before), days of the week, and months (as the latter two yielded significant differences in the previous study). Based on the lags in RTs identified for *dates* in the previous study this time unit was not included in the second study. Each of the three trials consisted of 54 tasks (18 per each unit, 9 in both directions, i.e., 9 related to postponing and 9 related to advancing). There was also a training trial of 6 examples before the main trial. Everything else in this procedure was the same as in Study 1. The procedure generally took around 25–35 min.

The main aim of the second study was to explore possible differences in RTs and responses for the three main types of orientation, between the four groups described above, but also to observe potential differences between the native speakers of the three examined languages.

3.2.3 Results

The first set of analyses was related to the mean response times. As for the leftward/rightward and the backward/forward orientation across populations and trials, we registered no statistically significant differences between the four populations based on one-way ANOVA tests ($p > 0.05$). In regard to the overall response time pattern, Figures 4 and 5 show that the mean response times in both the leftward/rightward and the backward/forward orientation expectedly decreased across trials, while the Mandarin-speaking population seemed to be slightly faster in responding compared to the remaining three.

The only orientation/axis where we found statistically significant differences was the vertical one, where the speakers of Mandarin performed even faster compared to the other three than in the previous two orientation pairs. There was a statistically significant difference between the groups as determined by one-way

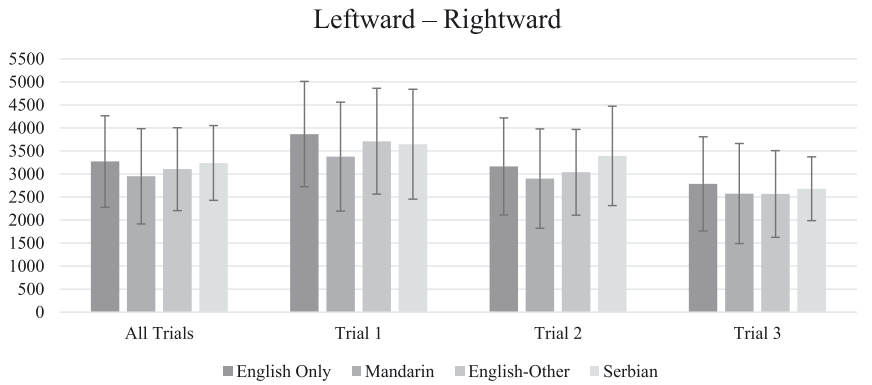

Figure 4: Mean response times (in ms) per population and trial (leftward/rightward).

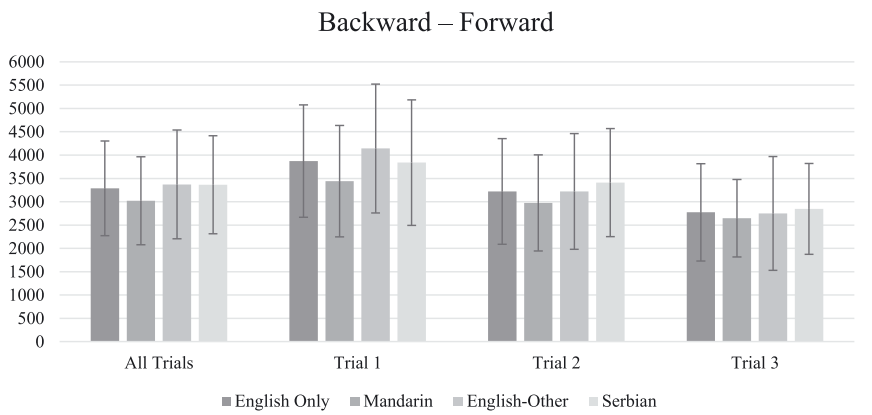

Figure 5: Mean response times (in ms) per population and trial (backward/forward).

ANOVA ($F(3,122) = 3.29$, $p = 0.02$, eta squared = 0.07). A Tukey post hoc test revealed that the mean response time of the Mandarin-speaking group ($M = 2{,}744.31$ ms, SD = 804.85 ms, $p = 0.03$) was significantly lower compared to those who spoke English only ($M = 3{,}419.49$ ms, SD = 1,032.29 ms). There were no statistically significant differences between the remaining pairs of groups. The mean values per trial and population are presented in Figure 6. The differences between groups were visible and statistically significant in Trial 1 ($F(3.122) = 3.23$, $p = 0.03$, eta squared = 0.07) and Trial 2 ($F(3,122) = 3.27$, $p = 0.02$, eta squared = 0.07), while they lost their significance in the final trial ($F(3,122) = 2.19$, $p = 0.09$, eta squared = 0.05).

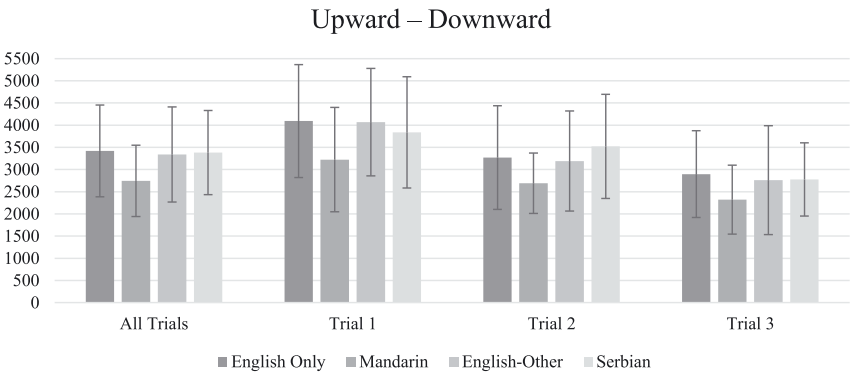

Figure 6: Mean response times (in ms) per population and trial (upward/downward).

Given the possible differences that can emerge on the time unit level, i.e., when only certain time units are taken into consideration, we extended the analysis of the vertical orientation to include the three time-unit levels we had used – parts of the day, days, and months. The results of the comparison that involved populations, trials and time units are presented in Figure 7.

One-way ANOVA tests revealed statistically significant differences only in the parts of the day condition in all three trials – Trial 1 ($F(3,122) = 5.70$, $p = 0.001$, eta squared = 0.12), Trial 2 ($F(3,122) = 3.98$, $p = 0.01$, eta squared = 0.09) and Trial 3 ($F(3,122) = 3.98$, $p = 0.01$, eta squared = 0.09). Based on Tukey post hoc tests, we could conclude that these differences mostly originated from the differences

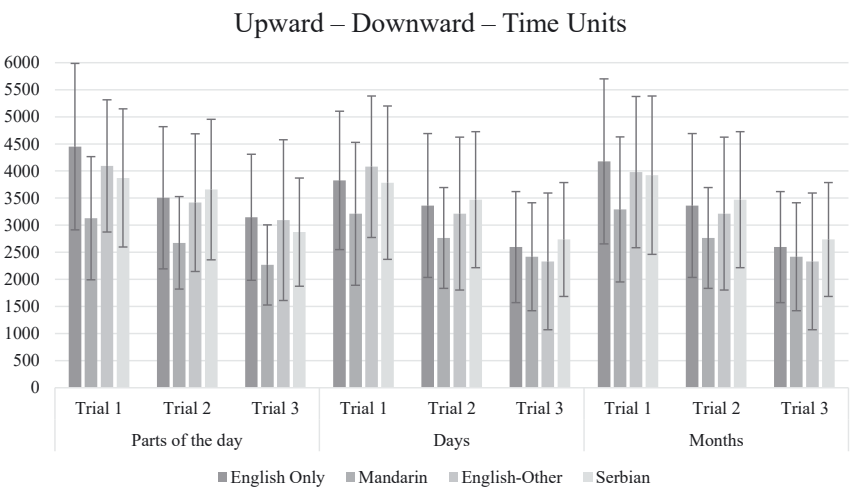

Figure 7: Mean response times (in ms) per population, trial, and time unit (upward/downward).

between the Mandarin-speaking group of participants, on the one hand, and the remaining three, on the other. When it comes to days and months, one-way ANOVA tests revealed no statistically significant differences in the three trials. As we can see in Figure 7, the differences between the groups kept reducing with each trial.

Finally, we wanted to test the structure of responses in each population in regard to postponing and advancing events in all three orientation conditions. The response structure is given as the percentage related to the respondents' choices and it is presented in Figure 8.

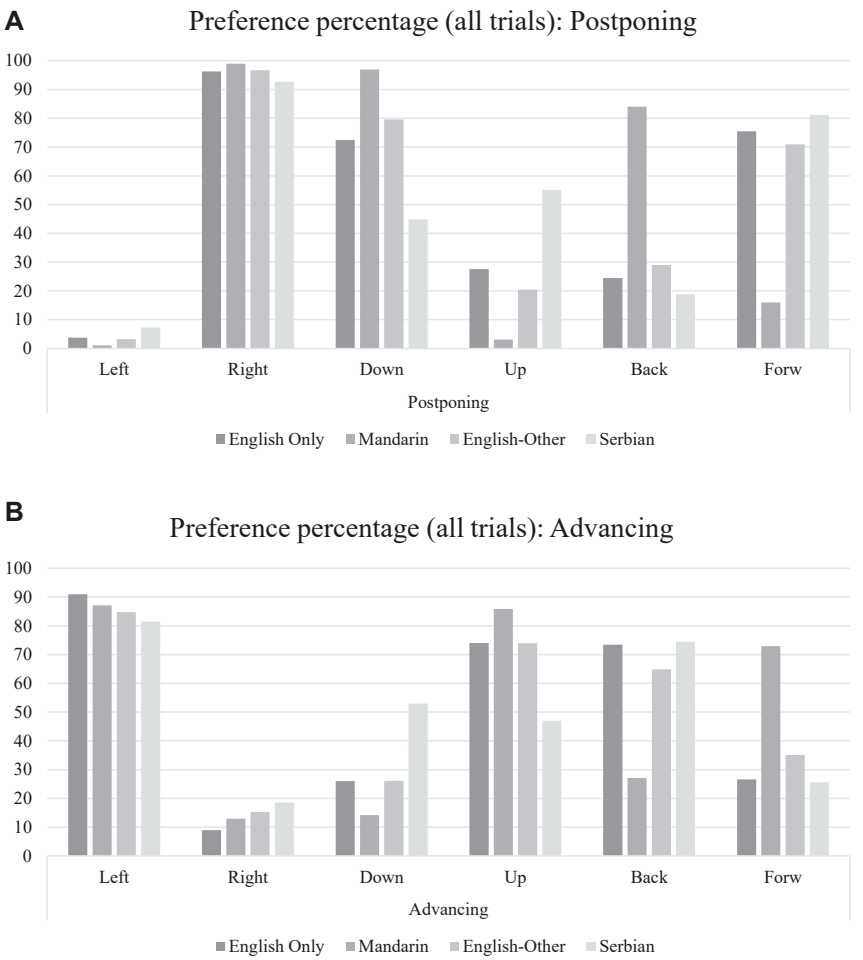

Figure 8: Percentage stats on directions preference for each orientation condition and population.

Figure 8 shows the overall consistency when it comes to the leftward/rightward orientation – both in the case of postponing and advancing, all four populations would mostly associate the future with the rightward direction, and the past with the leftward direction. The upward/downward condition seemed relatively stable for three populations (downward was associated with the future and upward with the past) – only the population of Serbian speakers exhibited a lack of consistency, similarly to what we witnessed in Study 1. Finally, in the backward/forward condition, all populations seemed to be consistent, but the speakers of Mandarin had the inverted response structure – whereas in the remaining three populations, the native English speakers, the respondents who spoke English and another language fluently, and the native Serbian speakers, the future was associated with the forward direction and the past with the backward direction, the population of Mandarin speakers, on average, gave the opposite responses.

3.2.4 Discussion

In this section, we briefly summarize the answers to the main research questions that the second study was designed to address.

(1) A comparison of the recorded mean response times did not reveal any significant differences between the four experimental groups for the transverse and sagittal axis. Additionally, the recorded response times for the two axes in all four groups showed a consistent decline between the first and final trials. The vertical axis, on the other hand, showed significantly faster response times for the speakers of Mandarin compared to the English speakers. The remaining comparisons for the vertical axis did not yield significance.
(2) The analysis of response times for individual time units for the vertical axis showed significant differences only for the parts of the day, in all three trials. Significantly faster responses were recorded for the speakers of Mandarin compared to all the remaining groups. The remaining comparisons did not reveal any significant differences between groups or trials.
(3) In the postponing condition, there was a very high degree of consensus between the four experimental groups for the transverse axis, inasmuch as almost all participants chose the 'right' response, and only a small percentage of participants opted for the 'left' response. A similar tendency for the transverse axis was also recorded for advancing. Namely, the great majority of participants chose the 'left' response in this condition. The distribution of responses for the remaining three axes was not as uniform, but quite the contrary. For the sagittal axis, Mandarin speakers showed an inverted trend compared to the remaining three experimental groups. In the postponing condition, the majority of them opted for the 'back' response, while the

remaining groups of participants mostly chose the 'forward' response. In the advancing condition, Mandarin speakers mostly opted for the 'forward' response, in contrast to the remaining participants. The responses concerning the vertical orientation introduced additional differences. In the postponing condition, the English Only, Mandarin, and English-Other groups predominantly opted for the 'down' response. This tendency was the most pronounced for the speakers of Mandarin, where nearly all participants chose the 'down' response. The Serbian speakers, on the other hand, showed an inverted trend, with a higher percentage of 'upward' responses (which is in line with the corpus-based studies and the results of Study 1). The results were similar for the advancing condition, where the speakers of Serbian again showed an inverted trend compared to the remaining three experimental groups – a higher percentage of 'down' compared to 'up' responses. When it comes to comparing the responses of the group of Serbian speakers in Study 1 and Study 2, we can notice that the advancing inconsistency was most striking in the downward-upward condition in Study 2 (while it existed in all axes in Study 1). The reaction times for the vertical axis were not significantly longer as compared to the other two in Study 2, which might be a result of a different selection of time units and the inclusion of a training trial.

(4) In comparison with the previous research in this field, we can first note that the Mandarin speakers in this study also had faster RTs in the case of the vertical orientation, but only for the part of the day unit. When checked against the overview presented in Bender and Beller (2014), the results related to the transverse axis coincide with the previous research in that postponing an event is mostly observed as movement in the rightward direction, while advancing as movement in the leftward direction, both in English and Mandarin (as well as Serbian). Our findings for the sagittal axis also follow the results of previous studies, with the noticeable difference between the Mandarin speakers, who mainly used the backward direction to postpone an event and the forward direction to advance it, and the other three groups, in which postponing and advancing were conceptualized as moving forward and backward, respectively. Even though Bender and Beller (2014: 360) report that in language elicitation tasks in English an event can also be moved backward as a way of postponing it, our results show a strong preference for the forward direction both in the English Only and the English-Other group. Finally, the results of our study related to the vertical axis corroborate the findings presented in the above overview, in which the past is up and the future down in Mandarin, while simultaneously confirming, at least to a certain extent given the detected inconsistencies, the conclusions of the corpus-based accounts in Serbian,

according to which the past is conceptualized as down and the future as up in this language.

4 General discussion

On the whole, the respondents were largely consistent in their assessment of the three adverbial pairs across the two studies, and the results yielded by the analyses of their responses were mainly as expected, both in terms of response times and orientations. However, several interesting findings emerged in the process of analysis and they will be discussed here in more detail along with the general summary of the similarities and differences between the examined groups of participants.

In the first study, which involved only native Serbian speakers, our main aim was to explore possible differences in participants' RTs in the three main types of orientation. The obtained results showed a greater degree of salience for the sagittal and transverse axes, while there were certain inconsistencies with the motion along the vertical axis. This was displayed in a statistically significant difference in response times between the former two and the latter type of orientation, with the respondents taking more time in deciding whether they viewed an event moved further into the future or the past as being moved up or down along the vertical axis.

Moreover, the response time was not the only significant indicator of their uncertainty in making such a decision, since they were also not able to consistently choose the same direction and express a preference for either the upward or the downward motion, especially when it came to moving an event to an earlier point in time, as advancing items proved to be particularly inconsistent across all axes. Their responses were more consistent in regard to postponing an event, where the upward direction was mostly used for moving it further into the future. It is also interesting to note here that the respondents themselves were largely consistent in their own answers – there were no significant discrepancies on the individual level, yet as a group they did not show a strong consensus on the upward/downward adverbial pair. The reason for this probably lies in the fact that they did not go through a training trial but went directly to assessing the given time units, and thus not being primed for the vertical axis, which is not common for time expressions in the Serbian language, they provided inconsistent responses on this type of orientation.

Contrary to this, their responses regarding the backward/forward and leftward/rightward directions were much more in line with each other, with rightward and forward being the preferred directions for postponing events, and leftward and

backward for moving them to a previous point in time, albeit this distinction was more pronounced for pushing an event further into the future than into the past. In addition to this, good agreement was also seen in the interpretation of the results both for different time units separately and for all of them lumped together. The breaking down of mean response times per time unit and orientation showed no major deviations from the lumped scores, with the observed differences closely matching those found when analyzing the results of all tasks as a whole. Also, the analysis of RTs for individual time units for all three types of orientation showed the greatest delays for dates, which also reached significance in some cases. Finally, comparing the participants' response time across the entire course of the procedure, it was determined that it gradually sped up as they became more adapted to the tasks at hand, which was also the case for all the other groups in the second study.

As for Study 2, the results presented in the previous section clearly show that there were no substantial differences between the groups comprising only native English speakers, only native Serbian speakers, and those who spoke another language alongside English. Both the response times and directions preferences were largely consistent across these three groups, where the future was mostly associated with the rightward, downward or forward motion, while the past was linked to the leftward, upward or backward motion, with a notable exception of native Serbian speakers and their already mentioned lack of consistency regarding the upward/downward condition. The only major deviation from this agreement was to be found in the population of native Mandarin speakers.

The respondents who spoke Mandarin as their mother tongue and English as their second language differed in their responses from the rest in several aspects. First of all, they were slightly faster in responding than the other three groups, regardless of the adverbial pair or the trial run in question, with mean response times decreasing across trials for all groups, again interpreted as a consequence of adaptation and training effects. This may be down to the difference in the respective orthographies of the languages used in the study, with a higher reading efficiency related to the logographic characters of Mandarin in comparison with the alphabetic written systems of English and Serbian (Lü and Zhang 1999). Additionally, He et al. (2018: 105) attribute Chinese speakers' greater flexibility in spatial conceptualization of time to cultural differences and more comprehensive thinking that also includes differences pertaining to logicality, ambiguity, and accuracy.

Secondly, the native Mandarin speakers showed an inverted understanding of the backward/forward direction, as opposed to the other three populations. Their responses remained mostly consistent within their group, associating the future with the backward motion and the past with the forward motion (see also Gu et al.

2019). Contrary to this, the other groups associated postponing with moving forward, while an event happening at a previous point in time was deemed as being moved backward. This difference was present in all time units. Such results also suggest that, while the remaining three groups were aligned with the timeline 'arrow', facing the future, thereby viewing the postponed events as located ahead on the timeline, the Mandarin speakers seem to have been oriented in the opposite direction and viewed the past as being in front of a timeline. The difference in the orientation on the sagittal axis is in agreement with Ahrens and Huang (2002), who contradict Yu's findings that Mandarin speakers face the future the same way that English speakers do and claim that "facing the past is the traditional and primary conceptualization of time in Mandarin" (Ahrens and Huang 2002: 511).

Lastly, another major specificity of the native Mandarin speakers was the way in which they related parts of the day to the vertical axis. Their results here were highly pronounced and differed significantly from the other groups, which was reflected in significantly faster RTs. The fact that there are no differences between the responses of this and the other three groups to the sentences containing days and months as time units, further points to the particularity of the spatio-temporal relation between the upward/downward motion and different parts of the day. Again, this can be related to conclusions outlined in He et al. (2018: 105), where the authors propose that "cultural differences might lead to different thinking styles." Moreover, they also stress the fact that more comprehensive thinking identified with Mandarin speakers affords more flexible conceptualizations of time (He et al. 2018: 106), which, in our case, has been evidenced by faster RTs for the parts of the day condition. This also reflects the import of the contextual use of language that is typically culturally determined (Robinson and Altarriba 2015: 240), which can be understood as one of the potential factors that afforded the identified difference for the Mandarin speakers in our procedure. Another possible reason for faster RTs may lie in the customary use of the top–down direction of writing in Mandarin (Bergen and Chan Lau 2012). In plain terms, we can assume that the repetitive use of idiosyncratic conceptual patterns afforded the construction of culturally-conditioned preferences, in effect yielding easier accommodation to these conceptualizations in real-time, reflected in faster RTs. As already shown above, the analysis of the other results of the two studies led to no further significant findings.

5 Conclusions

The present research included two studies. Study 1 involved native speakers of Serbian, and it was designed to investigate possible differences in RTs as a function of the three main types of orientation (leftward/rightward, backward/forward, and

upward/downward). The less salient 'movement' of events along the vertical axis showed the greatest degree of discrepancies, both in terms of increased RTs and in the distribution of participants' characterizations of events. In effect, it can be concluded that the vertical axis is neither a preferred, nor reliable way of describing the 'movement' of events on a timeline, as evidenced by the distribution of answers presented in Figure 3, and the comparison of RTs (see Figures 1 and 2).

Study 2 had a similar design and it involved four language groups: speakers of English (only), native speakers of Mandarin (who spoke English as their second language), native speakers of Serbian (who spoke English as their second language), and those who spoke English and another language. The main aim of this study was to explore possible differences in RTs and responses between the four groups and discuss the mechanisms that might facilitate those differences. The results obtained in this study showed an inverted conceptualization of backward/forward movement of events for the Mandarin speakers as compared to the remaining three groups. This view on the backward/forward pair, which is inverted in comparison to English and Serbian, has already been found in studies that involved Mandarin (e.g., Bender et al. 2010), but also in several other languages, including German (e.g., Rothe-Wulf et al. 2014), Tongan (Bender et al. 2010) and Aymara (Núñez and Sweetser 2006). Another idiosyncrasy with the Mandarin speakers has been identified for the case of the 'movement' of parts of the day conceptualized along the vertical axis. In line with previous research (e.g., He et al. 2018; Hong et al. 2017; Robinson and Altarriba 2015), the identified differences seem to be primarily licensed by cultural specificities and different thinking styles that afford nuances in conceptualizations of time as a function of space.

Overall, the findings obtained in the two studies reported in the present article have shown a high degree of consistency in participants' conceptualizations of time, with the certain specific differences outlined above. In effect, the findings obtained in the present two studies reinforce the notion of the existence of a strong conceptual connection between the domains of time and space. In the case of the Serbian language, the empirical results corroborate most of what we can find in theoretical and corpus-based accounts, with a particular emphasis on the vertical orientation in which the future is understood as being up, while the past is down, as opposed to the other examined languages. Finally, the results also have cross-cultural implications and we understand them not only as possible disambiguation devices in future studies of spatial conceptualization of time along the three main axes in different cultural contexts but also as a useful guideline for identifying speakers' preferences for conceptualizations of time in various stages of language acquisition and language learning.

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