Exploring time-telling expressions: A cross-linguistic study of German, Czech, and Russian*

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Abstract

This study explores how speakers of German, Czech, and Russian read analog clocks and which of the two distinct systems for expressing time (absolute or relative) they tend to prefer. Additionally, we investigated the reference point hypothesis in languages that have not previously been studied in this context. Our findings reveal that speakers of German, Czech, and Russian predominantly use relative expressions. Furthermore, our in-depth analyses of time expressions in Czech and Russian revealed a propensity to transition from the absolute to the relative system near the hourly reference point. Conversely, in German, more varied expressions were found around the half-hour region, where the reference point shifts from the past to the upcoming hour. These results provide new insights into the traditions of time-telling in a cross-linguistic comparison.

1 Introduction

Time exists in an intangible, abstract domain, yet it is a crucial dimension of our comprehension of life. The connection between time and the underlying mental concepts that form the basis of its understanding, as well as its expression through language, has been a subject of exploration for thousands of years (cf. Lewandowska-Tomaszczyk 2016). Since time cannot be studied directly, it must be approached through mental categories that manifest themselves in various linguistic constructs. Time finds its expression in cultural, semantical, and grammatical aspects of language, including event structure, lexical meanings, grammatical tense, and grammatical and lexical aspects (cf. ibid). Event structure is central to the temporal organization of events in language offering different conceptual frames of reference for telling time. Languages differ concerning how they convey time information. It can be expressed through lexical meaning such as temporal adverbs or adjectives like *yesterday*, *today*, and *tomorrow* as well as temporal prepositions like *before* and *after*. Grammatical tense can also be relevant when specifying the temporal relation between an action or event in relation to the time of utterance. The lexical aspect delineates how the inherent properties of verbs contribute to the temporal interpretation

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of events, taking into account factors such as durativity, punctuality, iterativity, or telicity. When it comes to the grammatical aspect, time is expressed through morphological and syntactic markings on the verb, which convey the temporal structure of events in a sentence. The use of these linguistic means depends on the language-specific properties of a given system.

The pivotal role of temporal reference and discourse lies in how language users perceive and frame a specific scene or event, representing a specific fragment of external reality. To enhance the otherwise subjective experience of time by providing a structured and precise way to understand and coordinate time-related activities, we use time-reckoning devices, such as calendars and clocks (cf. Evans 2004: 254). In this study, we adopt a psycholinguistic perspective on time cognition and investigate how speakers of three different languages read time from one of the most used time-representing objects: the clock. Two types of clock displays, analog and more recently digital, serve as the basis for two different and completely exchangeable systems of temporal expression: the absolute and the relative. When processing visual information, speakers of German, Czech, and Russian always have to choose between these systems: They can either use an absolute expression and state the hour information first, followed by the minutes (e. g. *two-twenty*), or mention the minute information before the hour and opt for a relative expression (e. g. *twenty past two*). Despite syntactical differences, their meanings are synonymous and interchangeable in standard contexts; both forms communicate identical temporal information without ambiguity (cf. Bock et al. 2003). The linguistic differences between relative and absolute expressions in German, Russian, and Czech are shown in Table 1. All examples in Table 1 come from the data collected for this study.

Time	Time expression					
	Relative			Absolute		
	German	Czech	Russian	German	Czech	Russian
4:20	*zwanzig nach vier*	*čtvrt na pět a pět minut/za deset (minut) půl páté*	*двадцать минут пятого*	*vier Uhr zwanzig*	*čtyři dvacet*	*четыре двадцать*
	‘twenty past four’	‘quarter out of five and five minutes’/‘in ten minutes half out of five’	‘twenty minutes of the fifth [hour]’	‘four hour twenty’	‘four twenty’	
4:25	*fünf vor halb fünf*	*čtvrt na pět a deset minut/ za pět minut půl páté*	*двадцать пять минут пятого*	*vier Uhr fünfundzwanzig*	*čtyři dvacet pět*	*четыре двадцать пять*
	‘five before half five’	‘quarter out of five and ten minutes’/‘in five minutes half out of five’	‘twenty-five minutes of the fifth [hour]’	‘four hour twenty-five’	‘four twenty-five’	

Time	Time expression					
	Relative			Absolute		
	German	Czech	Russian	German	Czech	Russian
4:35	*fünf nach halb fünf*	*půl páté a pět minut/za deset minut tři čtvrtě na pět*	*тридцать пять минут пятого/без двадцати пяти пять*	*vier Uhr fünfunddreißig*	*čtyři třicet pět*	*четыре тридцать пять*
	'five past half five'	'half five and five minutes'/ 'in ten minutes three-quarters out of five'	'thirty-five minutes of the fifth [hour]'/ 'without twenty-five five'	'four hour thirty-five'	'four thirty-five'	
4:40	*zwanzig vor fünf*	*půl páté a deset minut/za pět minut tři čtvrtě na pět*	*без двадцати пять*	*vier Uhr vierzig*	*čtyři čtyřicet*	*четыре сорок*
	'twenty to five'	'half five and ten minutes'/ 'in five minutes three-quarters out of five'	'without twenty five'	'four hour forty'	'four forty'	

Table 1: Relative and absolute time expressions for 4:20, 4:25, 4:35, and 4:40 in German, Czech, and Russian with a literal translation into English

It is worth noting that the opposite structure of relative expression (i. e., minute information preceding the hour) does not exist in every language. For instance, in Romance languages, Greek, Turkish, Arabic, and Persian, among others, the word order of relative expressions coincides with that of the absolute system (cf. Hatzidaki et al. 2014). For example, in European Spanish, the time 6:30 is stated as follows: las seis y treinta minutos ('six and 30 minutes') in the absolute form, or las seis y media ('six and half') in the relative form.

The selection of the languages considered here allows for comparisons along various linguistic and cultural dimensions. On the one hand, Czech and Russian belong to the Slavic language family. Even though both languages come from different subgroups (Russian belonging to the East Slavic and Czech to the West Slavic) they share a lot of lexical, grammatical, and structural similarities. On the other hand, Czech and German are part of the so-called Central European Sprachbund (cf. Nekula 2003). Due to their geographical proximity and historical interactions within this Sprachbund, these two languages, although typologically falling into different language groups, share numerous structural as well as lexical similarities. Research provides evidence that the influence of German extends beyond the lexicon (cf. Havránek/Fischer 1965) permeating into Czech grammar (cf. Berger 2009), and even the underlying conceptual preferences (cf. Mertins 2018). Through our comparative approach, with Czech as a pivot, we aim to investigate whether language contact or rather inherent language factors descending from a shared underlying system play a stronger role in shaping time-telling preferences.

Moreover, the existing literature on this topic has so far focused on language production among American English, Dutch speakers (cf. Bock et al. 2003), and English-Greek bilinguals (cf. Hatzidaki et al. 2014). While these studies have shed light on language-specific preferences, there remains a notable lack of research exploring this phenomenon across a broader linguistic spectrum. To address this gap, our study aims to investigate time-telling preferences in Czech, German, and Russian speakers. By expanding the scope of investigation to include these languages, we seek to provide valuable insights into cross-linguistic variations in temporal expression, thereby contributing to a more comprehensive understanding of language production processes. This comparative approach will not only enrich our knowledge of temporal expression across diverse linguistic backgrounds but also offer valuable implications for language teaching, intercultural communication, and cognitive science.

2 Structure of relative time expressions in Czech, German, and Russian

While the absolute time expressions are very similar for all three languages, the reference frames for relative time expressions are strikingly different. While telling relative time, Russian speakers always reference to the forthcoming hour (i. e., *четверть пятого*, 'quarter of the fifth [hour]'). The hourly framework in German functions quite differently compared to Russian. Up to the twenty-minute mark a speaker refers to the past-hour (*fünf*/*zehn*/*Viertel*/ *zwanzig nach H* 'five/ten/quarter/twenty past H') afterwards switching to the upcoming hour (*zwanzig*/ *Viertel*/*zehn*/*fünf vor H+1* 'twenty/quarter/ten/five before H+1'). Additionally, German speakers make use of a secondary reference point (RP) referring to the half-hour mark: The times :25 and :35 are counted as five minutes before/past the half-hour. The half-hour time is half of the next whole hour. Czech speakers also make use of an hourly framework, referencing the forthcoming hour. However, the times at :05 and :10 can also be referred to the previous hour (e. g. *pět minut po jedný*, 'five minute past one'). In addition, there are also three secondary RPs at the quarter-, the half-, and the third quarter-hour (e. g. *čtvrt na pět a deset minut*, 'quarter to five and ten minutes'). Thus, the linguistic structure of relative time expression, namely the presence of secondary RPs in German and Czech, distinguishes them from Russian.

The significant difference in handling analog and digital formats is not only evident on a linguistic level but can also be observed at the level of cognitive processing. Following Levelt's model of speech production (cf. Levelt 1989), Levelt/Roelofs/Meyer (1999) introduced the Levelt-Roelofs-Meyer model, which is the advanced theory of word production specifically addressing processes at the numerical level. According to this model, four planning levels in spoken numeral production can be distinguished: conceptual preparation (activation and selection of lexical concepts for the utterance); lemma retrieval (the retrieval of memory representation of syntactic properties of the lemma to be expressed); morphophonological form encoding (access to morphological and phonological information about the word) and phonetic encoding. By telling relative time from an analog clock, during the conceptual preparation the speaker must determine the minutes and hours by observing the clock's hand, identify the RP (past hour, half past the hour, quarter or three-quarter of the hour for Czech, or coming hour) along with calculating the time's distance from this RP in minutes. On the stage of lemma retrieval, the corresponding linguistic components (lemmas) must be accessed (e. g. *Viertel* 'quarter', *vor* 'to', *zwei* 'two') and syntactically ordered. In the stage of form encoding, the process continues

by retrieving the relevant morphemes (e. g. [vier], [tel]) and phonemes (e. g. /f/, /i:/, /ʁ/, /t/ and /l/). The retrieved phonemes are further organized into syllables, and the motor programs required for pronunciation are reconstructed (cf. Meeuwissen/Roelofs/Levelt 2004: 1239).

Korvorst/Roelefs/Levelt (2007) investigated whether the information from both clock formats was processed similarly. Participants were presented with various times in analog and digital formats that they had to identify and express. Naming latencies provided indications of conceptual preparation in speakers when they produced relative time expressions for both analog and digital clocks. Naming the absolute clock time from digital clocks is the quickest way of telling time because it doesn't include conceptual preparation. Instead, it only involves form encoding. These findings highlight the cognitive differences in processing relative and absolute time expressions across clock formats, suggesting that the format of time representation significantly influences the comprexity of conceptual preparation during speech production.

The current paper is organized as follows. The next section introduces an overview of previous research conducted on this topic. The subsequent section outlines the research questions and methodology employed in the experiment, while the following section presents the study results. A discussion of these findings and conclusions is provided in the final section.

3 Previous research

As mentioned above, the studies published on time expressions are either based on language production of American English speakers (cf. e. g. Bock/Irwin/Davidson 2004; Davidson/Bock/Irwin 2003; Kuchinsky/Bock/Irwin 2011) or Dutch speakers (cf. Meeuwissen/Roelofs/Levelt 2003, 2004; Korvorst/Roelefs/Levelt 2006, 2007). To our knowledge, only one study compares preferences in time telling across two languages (cf. Bock et al. 2003). Bock and colleagues (2003) analyzed time expressions in Dutch and US-American English and carried out three experiments. In the first experiment, they collected data from US-American (n = 144) and Dutch (n = 144) undergraduate students using paper-and-pencil questionnaires. Participants received a booklet consisting of a page of instruction and two clock displays, digital and analog, each on a separate page. They had to write out the depicted time in words in their native language. It was found that speakers of American English and Dutch have opposite preferences in time telling. US-American students used absolute expressions almost exclusively for digital as well as analog time displays, whereas Dutch undergraduates preferred using relative time expressions for both types of stimuli. The preference for absolute expressions by US-American participants was also shown in the follow-up studies (cf. e. g. Bock/Irwin/Davidson 2004; Davidson/Bock/Irwin 2003; Kuchinsky/Bock/Irwin 2011). Although the reasons for these findings are unclear, Bock et al. (2003) assumed the different preferences could be caused by the prevalence of digital displays in the United States compared to the Netherlands, or the fact that time expressions are taught differently in both countries.

Another result of the study refers to the preferences in the use of absolute and relative systems near the RPs (ibid.). More changes from absolute to relative expressions for US-American English speakers and from relative to absolute expressions for Dutch speakers were observed in the immediate proximity to the RPs: at the hour for English (e. g. *quarter/ten/five to H+1*) and the half-hour for Dutch (e. g. *H uur twintig/vijfendertig/veertig*, 'H hour twenty/-five/ forty'). This result was obtained with both types of displays and languages, even though Dutch and English

have opposite expression preferences and different RPs. These findings imply that the impact is not solely based on perception of clock formats or language, but rather on the interface between visual perception and verbal expression (ibid.). Additional evidence for the RP influence was found in the follow-up study by Bock/Irwin/Davidson (2004). They collected eye-tracking data from US-American English speakers. The participants had to name times from analog clock displays and received no explicit instructions regarding the type of time expressions to use. As expected, the majority of the elicited expressions consisted of absolute forms. A combination of three time values accounted for over 60% of the relative time expressions, namely :45, :50, and :55. To address the inquiry regarding the shift in time expressions from absolute to relative, Bock/Irwin/Davidson (2004) introduced the reference point hypothesis. Because the names of relative times in the second half of an hour include the name of the upcoming hour, competition from the approaching change in the reference hour in the absolute system may serve to activate relative times. For instance, at 8:55, where we hypothesize that the upcoming transition to the nine o'clock hour interferes with saying "eight fifty-five", the corresponding relative time is "five to nine". Thus, this hypothesis suggests that the naming patterns in proximity to an RP undergo interference due to heightened activation of the approaching reference hour.

Given that previous research in this field has focused primarily on English and Dutch, neglecting an exploration of time expressions in other languages, our study aims to fill this gap by specifically examining those in German, Czech, and Russian. Using a short paper-and-pencil task, we elicited time names for analog displays of clock times in three languages. The aims of this study are twofold: firstly, to assess the preferences of each language for different expressions, and secondly, to investigate the validity of the reference point hypothesis.

4 Experiment

4.1 Research questions and hypotheses

This experiment was designed to determine usage-based preferences for different time expressions in three languages: German, Czech, and Russian. Although relative (e. g. *quarter to four*) and absolute expressions (e. g. *three forty-five*) are both available in each language, they may not be equally favored by the speakers. In our experiment, we formulated the following research questions:

RQ1: What are the linguistic preferences for each form of expression in each of the three languages?

Given the lack of research on this topic regarding differences in time telling between Czech, German, and Russian, it would be appropriate to view this study as primarily explanatory. Without having specific prior hypotheses, we aim to understand and illuminate how individuals from these diverse language backgrounds express time.

RQ2: Is there a tendency to change the form of expression near RPs?

Based on the results from the experiment of Bock et al. (2003), we expected different preferences in the use of reference frames in the three languages and at different times around the

hour. By the reference point hypothesis, we predicted more changes from absolute to relative expressions, and vice versa, in the immediate proximity to the RPs.

4.2 Method

4.2.1 Participants

In the study, native speakers of German, Czech, and Russian were recruited (N = 396). The recruitment and data collection period for this study began on 27 April 2020 and concluded on 3 June 2021. The participation was voluntary and without financial compensation. All participants were fully informed about the study's aims, procedures, and their rights. Written informed consent was obtained from every participant before their involvement in the study. Additionally, we ensured that participants' confidentiality and anonymity were maintained following data protection regulations.

Depending on the native language of our participants, we divided them into three groups:

1. German native speakers (n = 132), aged 17 to 58 years (M = 25; SD = 8).
2. Czech native speakers (n = 132), aged 21 to 59 years (M = 31; SD = 8.3).
3. Russian native speakers (n = 132), aged 16 to 77 years (M = 36, SD = 14).

To identify any potential variations in language use influenced by age, we included individuals from different generations to provide a more comprehensive understanding of time expression usage among native speakers (cf. McDaniel/Shuster/Kennedy 2024). Age was selected as a variable because previous research has demonstrated that cognitive abilities related to temporal processing and linguistic performance can vary across age groups. For instance, McDaniel/Shuster/Kennedy (2024) found that 25% of younger adults scored below the expected range in Clock Drawing Test, exhibiting differences in their ability to process and express temporal information. These findings suggest that age may play an important role in shaping how individuals conceptualize and verbalize time. Consequently, we included participants' ages as a factor in the statistical model (section 4.3.2).

4.2.2 Ethical Considerations

Our research project adhered to the ethical principles outlined in the WMA *Declaration of Helsinki* (cf. WMA 1964/2025). In Germany, ethics approval for research is generally required when studies involve matters regulated by law, such as medical research, clinical trials, or the handling of sensitive personal data, following the guidelines set by national and institutional ethics boards. For social science research that does not fall under these regulated categories – such as our study, which did not involve medical interventions, physical risks, or sensitive personal data – there is no mandatory requirement for institutional review board approval.

4.2.3 Design and Materials

The materials consisted of 132 stimuli depicting five-minute time intervals in the 12-hour period between 12:05 and 11:55. Twelve clock pictures showing the time on the full hour were not used in the experiment because they do not provide information about the preference for relative or absolute expressions. Hence, eleven time points (from :05 to :55), each with twelve data points were collected. All times were depicted in analog format. This decision was

motivated by our specific interest in eliciting relative expressions, as we aimed to analyze reference points that occur exclusively in this type of expression. Analog clocks provide a visual frame that naturally triggers relative time expressions (cf. Bock et al. 2003). In contrast, digital formats tend to elicit absolute expressions (e. g. 2:15 or 2:50), which do not align with the focus of this study.

Bock et al. (2003) used stimuli in their experiments where the hour hand was fixed, always pointing to the hour information, while the minute hand moved to different positions, which is not common on a regular analog clock (see left in Figure 1). In our experiment, we opted for parametric hour hands, where the hour hand moves smoothly from one hour to the next as the minutes progress (see right in Figure 1). Whereas Davidson/Bock/Irwin (2003) revealed no statistically significant differences in perception between participants exposed to fixed-hour clocks and those exposed to parametric-hour clocks, we assumed this type of display would be more convenient for participants because such displays are commonly encountered in everyday context. Familiarity with these types of displays likely reduces cognitive load when interpreting the stimuli. Additionally, our stimuli contained numerical information for the hour to enhance the readability of the clocks. Previous studies have demonstrated that displays incorporating numerical information aid in expressing time (ibid.).

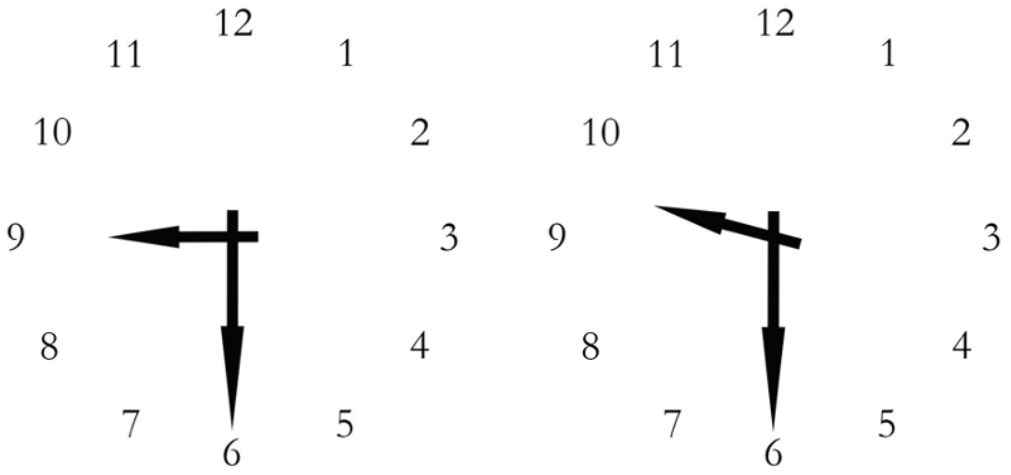

Figure 1: Examples of numbered fixed and numbered parametric clocks

For each participant, we compiled a booklet consisting of a page of short instructions, a questionnaire about the demographic and linguistic background, and one analog display on a separate page. Above each display, the following was printed (in German): “Wie spät ist es?” (‘What time is it?’) and “Es ist …” (‘It’s …’). In experiments with Czech and Russian participants, the equivalent expressions were used: “Kolik je hodin?” (‘What time is it?’), “Je…” (‘It’s …’) (in Czech), and “Сколько времени?” (‘What time is it?’) and “Сейчас…” (‘It’s …’) (in Russian).

Each participant was instructed that the minute hand always advances in a five-minute cycle. To prevent responses in numbers such as "12:35", participants were explicitly asked to write down the displayed time in words as naturally as possible.[1]

4.2.4 Limitations

The experimental design was adopted from the study of Bock et al. (2003), but several issues arose during the data analysis that will be addressed further. In the Czech version of the experiment, participants were prompted with the question "Kolik je hodin?" ('What time is it?'), "Je…" ('It's …'). The use of the singular verb form *je* ('is') in response may introduce a bias towards relative expressions for times between 2:05 and 4:55. In Czech, absolute expressions beginning with the numerals two, three, and four, typically use the plural form of the verb *to be* which is *jsou* (see 1a). For a clearer understanding of the differences in the usage of the verb *být* ('to be') in Czech concerning time telling, consider the following examples illustrating the absolute (1a) and relative (1b) expressions for the time 2:05.

(1a)	*Jsou*	*dvě*	*hodiny*	*pět*	*minut*
	are-3.PL	two	hours	five	minutes
	'It's two o'clock and five minutes'				
(1b)	*Je*	*za deset minut*	*čtvrt na tři*		
	is-3.SG	in ten minutes	quarter to three		
	'It's five minutes past two'				

Responses starting with the singular verb at 1:50 and 1:55 may tend to favor absolute expressions (see 2a), while those starting with the plural may lean towards relative expressions (see 2b):

(2a)	*Je*	*jedna*	*padesát*
	is-3.SG	one	fifty
	'It's one fifty'		
(2b)	*Jsou*	*za deset minut*	*dvě*
	are-3.PL	in ten minutes	two
	'It's ten to two'		

Notably, the singular form is also a viable option in this case and may even be favored by Czech speakers. Further research is required to determine which segments of the Czech population (and how frequently) opt for singular or plural agreement in such cases.

We decided to exclude the time expressions from 1:50 to 4:55 from the analysis addressing the first research question. Interestingly, the exclusion of this part of the data did not significantly affect the main result (see 4.3.1). In exploring the second research question, we included hour information as a random effect in the statistical model (see 4.3.2).

Further limitation of our study concerns the use of written responses to elicit time-telling expressions. While this method allowed for consistency and ease of data collection, it may not

[1] While this phrasing reflects the instructions given to participants, we acknowledge that responses may still have been influenced by the experimental nature of the task. Although every effort was made to create conditions conducive to natural language use, elicited expressions in an experimental setting cannot fully replicate spontaneous everyday speech.

fully reflect how individuals naturally express time in spoken interactions. Time-telling is predominantly a spoken activity in everyday life, with written forms being less common outside specific contexts (e. g. learning to tell time in school or formal scheduling). This raises questions about whether participants' written responses differ from what they might produce in spontaneous speech.

4.2.5 Data Analysis

We collected 396 responses in total (132 in each language). Utterances were classified as absolute expressions when the hour number was followed by the minute number, while they were categorized as relative when the words *quarter*, *half*, or the minute number preceded the hour number. These criteria were consistently applied across all three languages. Remarkably, when referring to the intervals surrounding the half-hour, some German participants used English-style relative expressions of the periods. Instead of the more customary 'five before half three', it was 'twenty-five past two'. We coded these expressions as correct and relative. The majority of the responses were accurate, except for one answer in Czech. The correctness of the answers concerning the displayed times was not considered in the scoring process.

Few responses employed the 24-hour system (e. g. *twenty-three hours twenty minutes* for a clock showing 11:20). Although 24-hour times are frequently employed in Germany, the Czech Republic, and Russia for formal scheduling purposes, comparable time expressions are rarely heard in casual conversation. Bock et al. (2003) drew similar conclusions regarding US-American English and Dutch, noting that while formal or institutional contexts (e. g. transportation schedules or military usage) often rely on the 24-hour system, speakers tend to default to the 12-hour format with relative expressions in everyday interactions.

4.2.6 Validation

The complete datasets were coded by the authors. To assess the reliability of the coding process, two coders with native proficiency in the analyzed languages independently coded 10% of the data, which consisted of a total of 42 utterances. The coding was conducted following the specified rules. Subsequently, intercoder reliability was calculated using Cohen's kappa index. The index was computed by dividing the number of actual matches by the total number of utterances. The resulting Cohen's kappa value between the two coders was .97, indicating an "almost perfect" level of agreement based on Landis and Koch's benchmarks for assessing the relative strength of agreement (cf. Landis/Koch 1977).[2]

4.3 Results

The subsequent section presents the findings according to the chronological order of the research questions formulated in section 4.1. The statistical analysis was performed using R Statistical Software 4.3.0.

[2] These benchmarks categorize agreement levels as Poor (< 0), Slight (.0–.20), Fair (.21–.40), Moderate (.41–.60), Substantial (.61–.80), and Almost Perfect (.81–1.0).

4.3.1 Results of RQ1

To answer this RQ, the first step involved conducting a descriptive analysis. As mentioned earlier (section 4.2.4), we excluded 35 Czech responses (for times between 1:50 and 4:55) for this analysis due to the potential influence of the singular verb form *je* in the instructions. Contrary to our expectations, the exclusion led to a one percent increase in the proportion of relative expressions (from 86% to 87%).

Speakers of all three languages showed preferences for relative expressions (Figure 2). While German and Czech participants predominantly used relative time expressions (92% and 87% respectively), Russian native speakers demonstrated a more balanced distribution between the two systems, with 36% utilizing absolute expressions and 64% employing relative expressions.

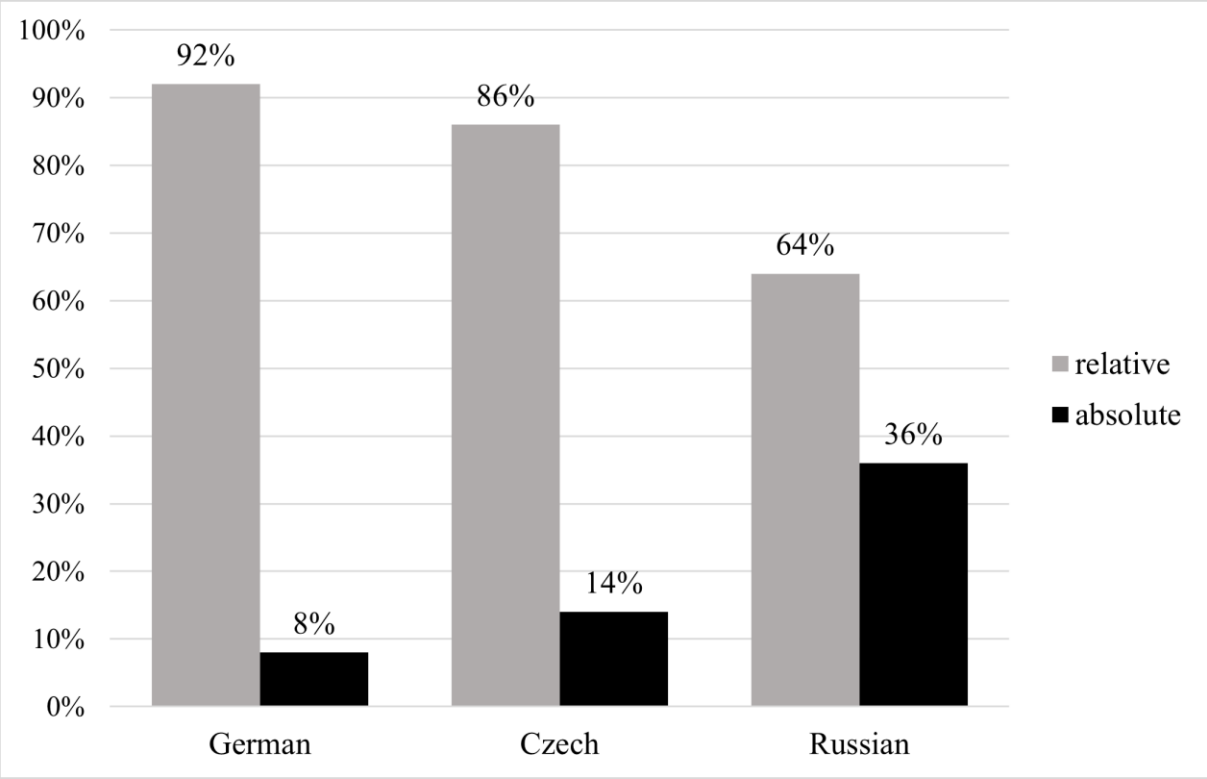

Figure 2: Percentages of relative time expressions (in gray) to absolute time expressions (in black) used in German, Czech, and Russian when writing down times from the analog clock

In addition, we conducted an exact binomial test initially for all three languages combined and then separately for each language, examining the distribution of observations across two categories of the statement form (absolute/relative). Each test yielded significant results. The output of a test applied to all data together and the German, Russian, and Czech data is shown in Table 2.

Language	Category	Number	Observed Proportion	Exact Sig. (2-tailed) p-value
Combined	Relative Absolute	290 71	.803 .197	**< .001**
German	Relative Absolute	122 10	.924 .176	**< .001**
Czech	Relative Absolute	122 10	.924 .176	**< .001**
Russian	Relative Absolute	84 48	.636 .364	**.002**

Table 2: Results of the exact binomial test for relative and absolute expressions across languages
Here and in the following tables, p-values lower than .05 are printed in bold.

The results demonstrate a statistically significant departure from the expected binomial distribution in both categories in each language, which indicates that the proportion is different from the null hypothesized value of 0.5: $p < .001$; $N = 361$ (all languages), $p < .001$; $n = 132$ (German) and $n = 97$ (Czech), $p = .002$; $n = 122$ (Russian). These findings suggest that speakers of all three languages generally expressed reported times with a preference towards relative expressions over absolute expressions.

4.3.2 Result of RQ2

In the next step, we examined in which range of the analog display the preference for switching the expression form occurs. As with English speakers (cf. Bock et al. 2003), a descriptive analysis showed a strong preference for change from absolute to relative expressions for Russian speakers near the hourly RP (see Figure 3). Until time :35, the preferences in time expressions are distributed fairly evenly, but from time :40 on, the proportion of relative time expressions increases significantly.

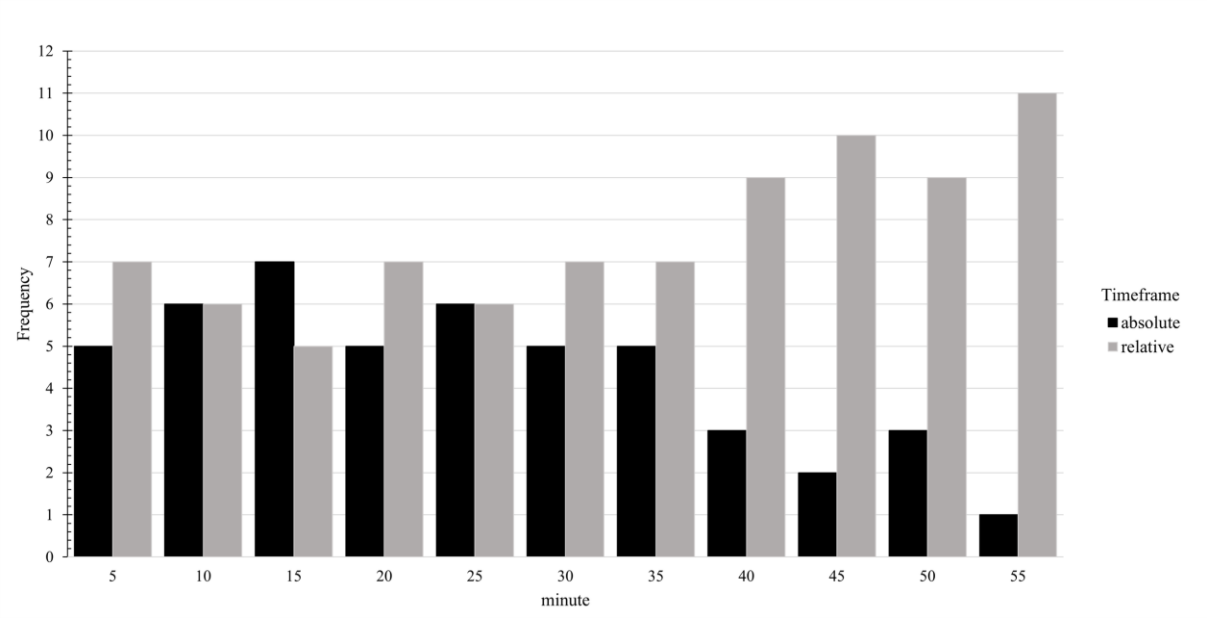

Figure 3: Absolute frequency of relative time expressions (in gray) to absolute time expressions (in black) used in Russian when writing down times

Similar to speakers of Dutch, German speakers switched more often from relative to absolute expression forms near the half-hour RP (see Figure 4). The locations where reference-point changes occur in German differ from those in Russian. For instance, at twenty-five minutes past the hour (:25), the RP shifts to the upcoming hour, and the preferred expression at this juncture is "five before half" of the next hour. Note that shifts in German RPs occur in a distinctly separate area of the analog clock compared to the changes in Russian. It is precisely at these junctures that the greatest variations in expression preference are noted on analog clocks.

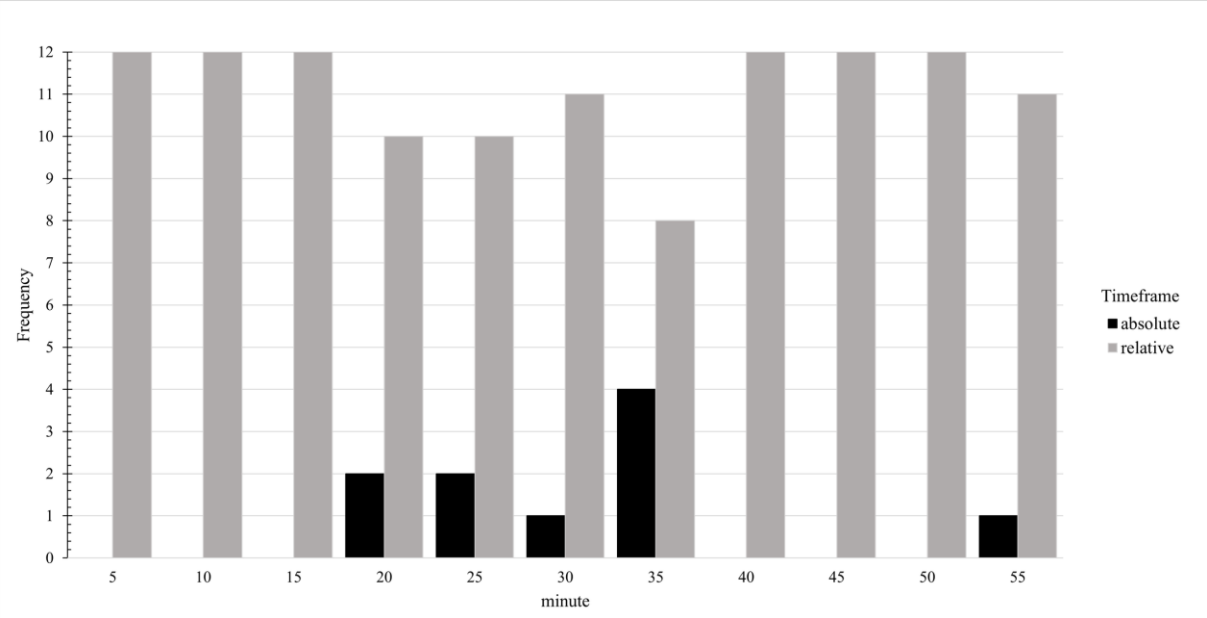

Figure 4: Absolute frequency of relative time expressions (in gray) to absolute time expressions (in black) used in German when writing down times

In the experiment, some German speakers employed an unexpected form referencing times close to the half-hour mark :25 and :35 (e. g. *fünfundzwanzig nach H*, 'twenty-five past H'; *fünfundzwanzig vor H+1*, 'twenty-five to H+1'). This deviation appears to stem from participants' efforts to avoid mentioning the secondary RP. The underlying reasons for this behavior remain unclear. On one hand, it may represent a tactic to streamline the relative expressions by omitting the secondary RP. On the other hand, the unexpected pattern could be attributed to the influence from the English language. Further research concerning this topic is needed.

Since relative time expressions in the Czech language combine features from both Russian (related to the upcoming RP) and German languages (related to secondary points of reference), we were interested in examining the results displayed by Czech native speakers.

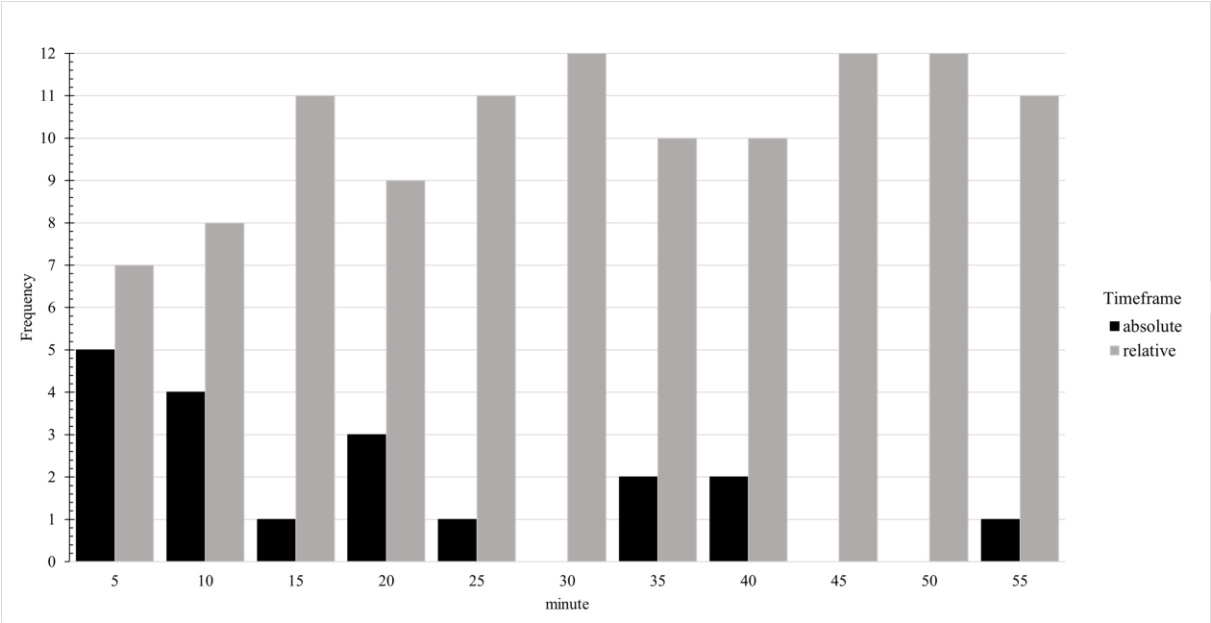

Figure 5: Absolute frequency of relative time expressions (in gray) to absolute time expressions (in black) used in Czech when writing down times

Figure 5 shows that Czech speakers, similar to Russians, tend to shift from using absolute to relative expressions as they approach the primary RP. No recognizable influence of secondary RPs, as seen in German, can be observed.

To assess the impact of the RP on changes in statement form, we employed regression analysis using a Generalized Linear Mixed Model (GLMM). The choice of a GLMM for our analysis can be justified by its suitability to our dataset's characteristics. GLMMs allow us to simultaneously estimate both fixed and random effects. This approach is especially advantageous when the dependent variable is binary, as GLMMs are well-equipped to model binary outcomes while accounting for the correlated nature of the data. By incorporating random effects, we can effectively capture variability between groups or clusters, enhancing the robustness of our analysis and providing more accurate estimates of the effects of interest (cf. Dean/Nielsen 2007; Bono/Alarcón/Blanca 2021).

We used GLMM with maximum likelihood parameter estimation (Laplace Approximation), specifically modeling a binomial response variable with a logit link function across the entire dataset with the German language as a reference level. We conducted statistical analysis in R using the **`glmer()`** function of the **`lme4`** package (cf. Bates et al. 2015).

The following variables were defined for the test: statement form (absolute/relative) as the dependent variable, distance to the nearest RP, along with the distance to the RP in the future, languages (Czech, Russian), and interactions between languages and distance to the RPs as independent variables with an hour as a random intercept. Due to the wide age range of participants (especially in the case of the Russian group) and the potential age-dependency of various time-telling expressions, with younger generations possibly favoring more digital-based expressions, we also included in the statistical model the age of participants as a fixed factor. In the model output, a singular fit with zero variance was observed for the random intercept of an hour. This result suggests that there was no meaningful variability between hours. Therefore, we opted to remove the random effect for the hour from the main statistical model, as eliminat-

ing components with zero variance will not alter any of the estimated values (cf. Pasch et al. 2013).

As demonstrated by the descriptive and graphical analysis of the data, significant differences exist between languages regarding the type of expression more likely to be employed by the speaker (see Figures 2, 3, 4, and 5). Therefore, in the subsequent step, the interaction between language and distance (distance to the nearest RP/distance to the RP in the future) was investigated using a Likelihood Ratio Test (LRT). Since we excluded the random effect from the analysis, we compared two regression models (GLM) using LRT. The following variables were defined for the first model with language/distance interaction: statement form (absolute/relative) as the dependent variable, distance to the nearest RP, distance to the RP in the future, languages (Czech, Russian) as independent variables, along with interactions between language variables (Czech/Russian) and distance variables (distance to the nearest RP and distance to the RP in the future). The second model included only the main effects without the interactions between language and the RP. The Likelihood Ratio Test revealed a significant difference in model fit between the two models ($\chi 2 = 11.713$, df = 4, p = .020), indicating that Model 1 provides a significantly better fit to the data than Model 2. This suggests that the distance has a different effect depending on the language. Therefore, we proceeded to analyze each language separately using GLMM to assess the significance of the predictor variables.

The following variables were defined for the separate tests: statement form (absolute/relative) as the dependent variable, distance to the nearest RP, distance to the RP in the future, along with the age as independent variables with an hour as a random intercept. The output of a GLMM applied to the German, Russian, and Czech data is shown in Tables 3, 4, and 5.

Predictors	Dependent variable			
	Statement form (absolute/relative)			
	Estimate	Standard error	z-value	p-value
Fixed effects				
(Intercept)	2.077	1.567	1.325	.185
Age	.006	.046	.138	.890
distance to the nearest RP	.242	.115	2.104	**.035**
distance to the RP in the future	-.074	.041	-1.816	.069
	Variance		SD	
Random effect				
hour (Intercept)	.237		.357	

Table 3: Output of a GLMM applied to the German data

After adjusting for multiple comparisons using a Bonferroni correction (.05/3 = .0167), the distance to the nearest RP was weakly significant (p = .035), similar to the distance to the RP in the future (p = .069).

Predictors	Dependent variable			
	Statement form (absolute/relative)			
	Estimate	Standard error	z-value	p-value
Fixed effects				
(Intercept)	2.150	.888	2.422	**.015**
Age	.010	.014	.7	.483
distance to the nearest RP	-.036	.025	-1.455	.146
distance to the RP in the future	-.042	.014	-3.030	**.002**
	Variance		SD	
Random effect				
hour (Intercept)	.203		.45	

Table 4: Output of a GLMM applied to the Russian data

In Russian, the significant result was obtained only for the upcoming RP as a predictor: p = .002.

Predictors	Dependent variable			
	Statement form (absolute/relative)			
	Estimate	Standard error	z-value	p-value
Fixed effects				
(Intercept)	2.981	1.439	2.072	**.038**
Age	.021	.034	.593	.553
distance to the nearest RP	-.335	.265	-1.261	.207
distance to the RP in the future	-.057	.106	-.541	.588
	Variance		SD	
Random effect				
hour (Intercept)	.092		.303	

Table 5: Output of a GLMM applied to the Czech data

None of the variables in Czech showed a significant impact. The lack of a significant effect in the Czech data can be explained by the greater variability in possible RPs and the insufficient number of measurements resulting from it. Furthermore, the results do not show that age significantly influences the statement choice across all three languages for our sample.

To further check for the potential influence of the variable hour, which may be affected by the different verb forms used in responses (see 4.2.4), we compared two models (one with a random effect and the other without this effect) using LRT. The likelihood ratio test yielded a statistic (Chi-square = .0662) with 1 degree of freedom, resulting in a p-value of .7969. Given that this p-value exceeds the conventional significance threshold of .05, we fail to reject the null hypothesis. Consequently, there is no significant difference in model fit between models with and without random intercept. This suggests that the inclusion of the variable hour as a random intercept does not significantly enhance the model fit.

To gain further insights into the Czech data, we decided to examine only relative expressions (a total of 80 expressions). We also reduced the number of RPs by combining them into two general categories, depending on whether the speaker refers to the preceding or following RP. As a reminder, Czech speakers have multiple options for expressing time using the relative system. For example, 2:05 can be conveyed by referring to a previous hour as *pět minut po druhé* (‘five-minute past two’), and to the quarter as *za deset minut čtvrt na tři* (‘in ten minutes quarter to three’).

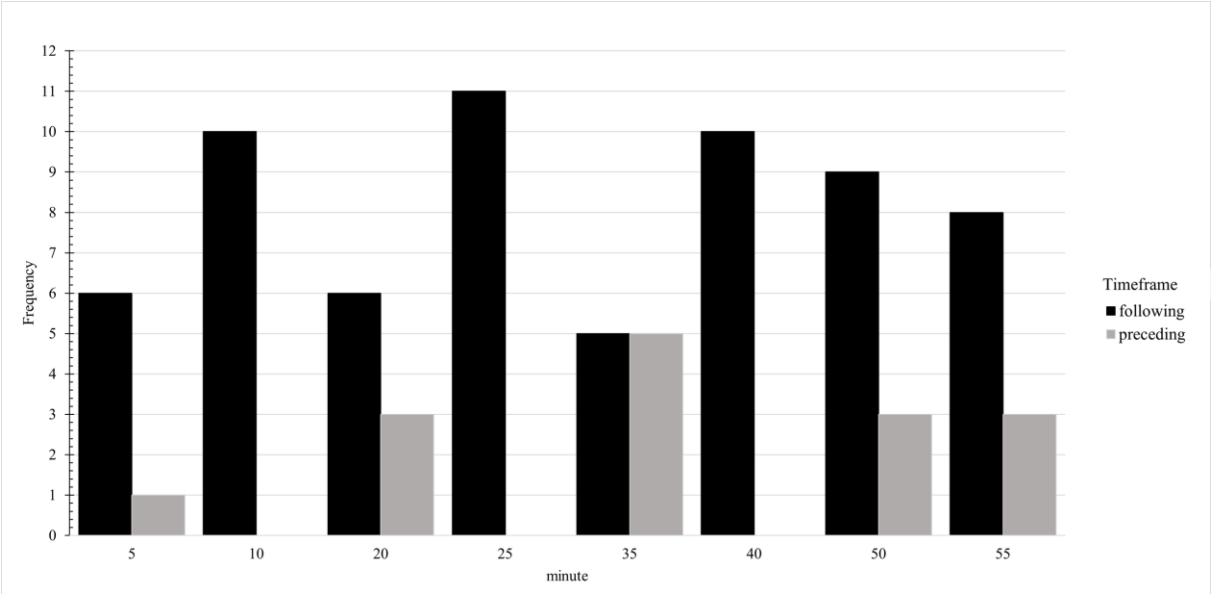

Figure 6: Absolute frequency of relative time expressions referring to the following RP (in black) to relative time expressions referring to the preceding RP (in gray) used in Czech when naming times

Eighty-one percent of all relative time expressions refer to the following RP. More variations were observed for times following the secondary referent points at :20; :35; :50.

5 Discussion

The data analysis shows that speakers of all three languages prefer relative over absolute expressions when telling time in written form on analog clocks: German 92%; Czech 87%; Russian 67%. However, in Russian, this distinction was not as pronounced as in German and Czech, and Russian speakers also used the absolute system to tell times.

The preference for relative expressions may have been influenced by the use of analog clock displays as stimuli in this study. Specifically, their spatial geometry and motion direction of the hands, which align naturally with prepositions used in relative expressions (e. g. *nach*, ‘past’; *vor*, ‘to’ in German; *za*,‘in’; *po*, ‘past’; *na*, ‘to’ in Czech, and *без* [*bez*], ‘without’ in Russian). Previous experiments have shown weak compatibility effects between visual stimuli and the choice of expression type – at least among Dutch and US-English speakers (cf. Bock et al. 2003; Bock/Irwin/Davidson 2004). As Bock et al. suggested, conventional, cultural, and educational factors likely interact to shape these strong preferences (cf. Bock et al. 2003: 661).

To better understand potential educational influences, we examined schoolbooks and curricula for preschools and primary schools across Germany, the Czech Republic, and Russia (cf. e. g. Beerbaum et al. 2021; Brebeck et al. 2018; Dorofeev/Mirakova 2011; Dorofeev/Mirakova/Buka 2015; Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen 2008;

Ministerstvo Prosveshcheniya Rossiyskoy Federatsii/Institut Strategii Razvitiya Obrazovaniya Rossiyskoy Akademii Obrazovaniya 2022; Ministerstvo Prosveshcheniya Rossiyskoy Federatsii 2022; Moro et al. 2012; Mühlhauserová/Svobodová 2018; Vasileva/Gerbova/Komarova 2005).

This analysis revealed no significant differences regarding when the time-telling is introduced in curricula. Children typically encounter clock reading by the age of six to seven years at the latest. In Russia and the Czech Republic, children begin learning to read time from analog clocks during kindergarten. By the end of their final year at kindergarten, they are expected to distinguish durations of time intervals (e. g. 1 minute, 5 minutes, 10 minutes, and 1 hour) as well as read both analog and digital clocks with accuracy up to a quarter-hour. In Germany, similar competencies are acquired during first grade as part of math class. In second grade, children learn to read minutes from the clock.

In summary, the educational factor likely has no impact on the choice of time expression form, as the curricula are similar across languages. However, this finding may be less relevant, as the experiment participants were probably not influenced by the current school curricula. To investigate cultural factors, such as the usage of analog clocks, pragmatic issues (e. g. time-telling in different contexts), and time-telling traditions within a community or across different age groups, separate research is needed.

Our findings also highlight that the presence of secondary RP(s) can impact the preference for relative forms in Czech and German. The additional RPs may serve as anchor points breaking down the clock face into smaller parts, offering speakers additional spatial support by interpreting the depicted time and providing them with a wider range of ways to name times. Addressing this issue, we analyzed the influence of RPs in more detail and found evidence supporting the reference point hypothesis.

Our descriptive analysis of Czech and Russian expressions revealed a tendency for the change from the absolute to a relative system near the hourly RP. On the other hand, in German, more variable expressions were obtained around the half-hour region, where the secondary RP is located, and where the hourly RP transitions from the past to the upcoming hour. The statistical analysis indicated a significant result for the upcoming RP in Russian. In German, both the distance to the upcoming RP and the distance to the next RP revealed weak significance. No significant effect of secondary RPs in Czech data was found. We explained it by the greater variability in possible RPs and the insufficient number of measurements resulting from it. Therefore, we decided to examine Czech relative expressions in more detail. As with the shift from the absolute to the relative system near the hourly RP in Russian (and as observed in English in the study of Bock et al. 2003), Czech speakers prefer referring to the RP situated in the future rather than in the past. This finding implies that the anticipation of the upcoming RP may significantly influence the linguistic choices made by speakers. Specifically, it suggests that speakers may adjust their expression of time based on their awareness of impending temporal landmarks, such as the transition to the next hour. This phenomenon highlights the dynamic interplay between cognitive processes, linguistic conventions, and temporal cognition in shaping how individuals conceptualize and communicate time.

The results from our sample indicate that age does not significantly influence the choice of time-telling form across all three languages. However, previous research (e. g. McDaniel/Shuster/Kennedy 2024) has suggested that age might play a role in shaping time-telling preferences, particularly with younger generations potentially favoring more absolute expressions due to the widespread use of digital clock displays. Given this potential influence reported in the literature, further research could explore age-related variations in statement choice within specific language communities. This strand of research would provide valuable insights into how linguistic and cultural factors intersect with age in shaping time-telling preferences.

While our study primarily focused on linguistic preferences, drawing definitive conclusions regarding cross-linguistic and cultural influences would be premature. Moreover, our findings reveal that German and Czech speakers demonstrate similar tendencies in time-telling preferences, with secondary RP(s) distinguishing their relative system from Russian. Further research should delve more deeply into cultural and historical influences, providing more comprehensive insights into the factors shaping time-telling preferences across languages.

Our findings indicate that variations in how people express time on clocks near RPs are affected by competition from alternative ways of structuring time expressions, which are language-specific, and this competition is influenced by changes in the RP. Our results demonstrate that RPs act as anchors within the structural framework for expressing relative time, indicating that they play a significant role in how time is conceptualized and communicated. To further address the impact of RPs on the choice of relative time forms, contrastive research is needed across other Slavic (e. g. Slovak or Slovenian) and Germanic languages (e. g. Swedish, Danish, or Norwegian) that share a similar structure of relative time-telling.

To further explore the impact of RPs during the conceptualization phase, an eye-tracking study will be conducted in the next step. Thematically, this will focus on the reception of analog clock displays. Unlike the current study, where participants wrote down their responses, this experiment will involve spoken time-telling. This approach addresses a key limitation of the present study by allowing us to examine how speakers naturally verbalize time while simultaneously tracking their visual attention. We are particularly interested in how speakers of languages with clear preferences for a particular system of time expressions look at the clock and which region (minute or hour hand) they tend to fixate on first. Bock/Irwin/Davidson (2004) found a reversed fixation pattern among US-American speakers: even when telling time relatively, participants often looked at the hour region before the minute region. One of the explanations for the reversed fixation pattern was that our linguistic preferences influence the way we process visual information. We are interested in whether we will find similar gaze preferences in Czech, German, and Russian speakers.

In conclusion, the current study sheds new light on the preferences in time-telling by speakers of the Czech, German, and Russian languages. The results demonstrate that the speakers of Czech and German predominantly employ relative expressions when reading time from an analog clock, whereas the speakers of Russian utilize both relative and absolute expressions. Furthermore, statistical analysis revealed that the RPs affect the choice of the expression. In our study, we address a significant gap in the existing literature by exploring time-telling preferences among speakers of the Czech, German, and Russian languages, which have been under-

studied in this context. Our results contribute to a more comprehensive understanding of time-telling conventions in the field of linguistics.

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