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Trans-paradigmatic syncretism in case form processing in Russian

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ABSTRACT

The paper presents two experiments which studied processing of different case forms of Russian nouns in a sentential context. Target sentences contained a preposition requiring a particular case, and in different experimental conditions, we used a noun in the correct case or in several other cases after it. Many previous studies have compared case forms in isolation, both in Russian and in other languages, but our study revealed that different factors played a role in a sentence: grammaticality and trans-paradigmatic syncretism of case affixes. The former finding was expected, while the latter was novel. Trans-paradigmatic syncretism is discussed in several theoretical approaches and usually assumed to be purely accidental. Its relevance for processing is important both for theoretical morphology and for psycholinguistics.

KEYWORDS sentence processing · case · syncretism · morphological decomposition

1 INTRODUCTION

We report the results of two experiments which studied processing of different case forms of Russian nouns in a sentential context. Target sentences contained a preposition requiring a particular case, and in different experimental conditions, we used a noun in the correct case or in several other cases after it. Many previous studies have compared case forms in isolation, both in Russian and in other languages (Gor et al. 2017, Järvikivi & Niemi 2002, Lukatela et al. 1987, Milin et al. 2009, Müller 2004, Vasilyeva 2018), but we hypothesized that different factors may play a role in a sentence.

Indeed, no factors shown to play a role in isolation, like case frequency, influenced reading times. Instead, two other factors were significant: grammaticality and trans-paradigmatic syncretism of case affixes (for example, when a dative singular affix in one inflectional class coincides with an accusative singular affix in another class). The former finding was expected (with very rare exceptions, grammatically correct forms are processed faster than incorrect ones), while the latter was novel. Trans-paradigmatic syncretism receives different treatment in theoretical approaches to Russian noun morphology. However, it has never been demonstrated to play a role in processing. Therefore, our findings are relevant both for theoretical morphology and for several important psycholinguistic debates, including the question of how word forms and inflectional affixes are represented in the mental lexicon.

2 INFLECTION OF RUSSIAN NOUNS

Russian nouns are inflected for six cases (nominative, genitive, dative, accusative, instrumental and locative) and two numbers (singular and plural). They have different sets of inflections depending on the inflectional class, or declension, they belong to. Traditional reference grammars (e.g. Shvedova 1980), as well as many other studies (e.g. Aronoff

1994, Halle 1994), identify three declensions with several subparadigms and various exceptions. They are shown in Table 1.[1]

	D1 in singular		D2 in singular	D3 in singular	Plural
	masculine	neuter	mostly feminine	feminine	all declensions
Nom	Ø	*o/e*	*a*	Ø	*y/i* or *a*
Gen	*a*		y/i	i	*ov/ev* or Ø or *ej*
Dat	u		*e*	*i*	*am*
Acc	= Gen/Nom	= Nom	*u*	= Nom	= Gen/Nom
Inst	*om/em*		*oj/ej*	*ju*	*ami*
Loc	*e*		*e*	*i*	*ax*

Table 1: Case inflections of Russian nouns

Alternative approaches to inflectional classes either divide the first declension in Table 1 into two classes with masculine and neuter nouns (e.g. (e.g. Alexiadou & Müller 2008, Corbett & Fraser 1993, Müller 2004), or make a primary distinction between the 1st and 2nd ('core') declensions on the one hand and the less frequent 3rd declension on the other hand (e.g. Zaliznjak 1987, Wiese 2004). In the latter case, it is assumed that the choice of endings is predetermined by the declension and the gender of the noun. Our experimental findings can be discussed using any of these approaches, and we will rely on the one in Table 1 for the sake of convenience.

Since case frequency is considered to be a crucial factor in many experimental studies, let us discuss it for Russian cases. Slioussar & Samoilova (2015) provide the following counts based on the Russian National Corpus (www.ruscorpora.ru): 30% nominative forms, 26% genitive forms, 19% accusative forms, 10% locative forms, 9% instrumental forms, 5% dative forms. Other frequency counts based on different corpus samples can be found in Kopotev (2008), but the order of cases remains the same. Slioussar & Samoilova's 2015 database also shows that this order is the same in different declensions, but differs for animate and inanimate nouns: in the former, it is nominative > genitive > accusative > dative > instrumental > locative. Crucially, nominative, genitive and accusative are still markedly different from the three remaining cases, so, if any effects of frequency are expected, one should first observe a distinction between these two groups.

As Table 1 makes clear, there are many instances of intra-paradigmatic and trans-paradigmatic syncretism: inflectional affixes often coincide both within one paradigm and across paradigms. Starting from the foundational study by Jakobson (1936/1984), different instances of intra-paradigmatic syncretism in Russian are discussed in all major theoretical frameworks (e.g. Alexiadou & Müller 2008, Baerman et al. 2005, Brown & Hippisley 2012, Caha 2008, 2021, Corbett & Fraser 1993, Franks 1995, Halle 1994, Neidle 1988, Sims 2018, Müller 2004, Stump 2001, Wiese 2004). Explaining trans-paradigmatic syncretism, for example, the fact that *-u* is used in dative singular in the 1st declension and in accusative singular in the 2nd declension or the fact that *-a* is used in genitive singular in the 1st declension and in nominative singular in the 2nd declension, is much trickier. Most authors assume that such coincidences are purely accidental, and only Müller pursues the radical hypothesis that identity of form always implies identity of function (Müller 2004; see also Alexiadou & Müller 2008).

In Müller's model, three binary features [±subject], [±governed] and [±oblique] are used to represent the six cases: nominative is [+subj,–gov,–obl], genitive is [+subj,+gov, +obl], dative is [–subj,+gov,+obl], accusative is [–subj,+gov,–obl], instrumental is [+subj, –gov,+obl] and locative is [–subj,–gov,+obl]. Two abstract binary features [±α] and [±β] are used for inflectional classes: masculine nouns of the 1st declension are [+α,-β], neuter

[1]The 2nd declension contains the majority of feminine nouns and a small number of masculine nouns. The choice between *o/e*, *y/i* etc. depends on the final consonant of the stem. The choice of ending in accusative depends on animacy. The choice of endings in nominative and genitive plural is regulated by more complex rules that are not directly relevant for our study.

nouns are [+α,+*β*], 2nd declension is [-α,+*β*], and 3rd declension is [-α,-*β*]. The rules regulating the choice of noun inflections in the singular are given in (1).

(1) /oj/ — [+N], [–α,+*β*], [+subj,–gov,+obl]
/ju/ — [+N], [–α,–*β*], [+subj,–gov,+obl]
/om/ — [+N], [+α], [+subj,–gov,+obl]
/e/ — [+N], [–α,+*β*], [–subj,+obl]
/e/ — [+N], [+α], [–subj,–gov,+obl]
/o/ — [+N], [+α,+*β*], [–obl]
/Ø/ — [+N], [–*β*], [–obl]
/i/ — [+N], [–α], [+obl]
/u/ — [+N], [–subj,+gov]
/a/ — [+N]

The analysis is based on underspecification and specificity-based competition, with /oj/ and /ju/ being the most specific affixes and /a/ and /u/ the least specific. Thus, the trans-paradigmatic syncretism of -a or -u is explained by their low specificity. The model does not account for the trans-paradigmatic syncretism of -e: there are two instances of this affix in (1). Let us also note in advance that our experiments did not support this model.

3 PREVIOUS EXPERIMENTAL FINDINGS

Most previous studies of case processing have investigated differences between noun forms presented in isolation (e.g. Gor et al. 2017, Järvikivi & Niemi 2002, Lukatela et al. 1987, Milin et al. 2009, Vasilyeva 2018). Almost all experiments have found that nominative forms were processed faster than other forms, and further differences between non-nominative forms were also discovered in some studies. The factors invoked to account for these differences have included case frequency, intra-paradigmatic syncretism of case affixes, and inflectional entropy, as well as case hierarchies suggested in different theoretical approaches (e.g. Blake 2001, Caha 2008, 2021, Jakobson 1936/1984).[2]

However, morphological processing in isolation and in context may be influenced by different factors (Bertram et al. 2000, Hyönä et al. 2002). For example, an experiment on Finnish demonstrated that in isolation, inflected nouns were read more slowly than monomorphemic nouns, but this difference disappeared in a sentential context — arguably, because readers expected certain inflections (Hyönä et al. 2002). Two studies analyzed Russian noun processing in a sentential context. Firstly, an eye-tracking study by Stoops & Christianson (2017, 2019) compared only nominative and accusative forms. Secondly, Slioussar & Cherepovskaia (2014) focused on the role of adjective form syncretism in the processing of noun case errors.

Slioussar & Cherepovskaia (2014) looked at case errors on nouns following various prepositions, as we do in the present study, so let us focus on their experiments in more detail. They analyzed examples like (2) and (3) in word-by-word self-paced reading and grammaticality judgment experiments. Here and below, target noun forms in different experimental conditions are separated by slashes.

(2) Neudači v prošl-yx sezon-ax / *sezon-ov /
failures in previous-LOC=GEN.PL seasons-LOC.PL seasons-GEN.PL
*sezon-am zastavili komandu potrudit'sja.
seasons-DAT.PL made team.ACC to-work
'Failures in the previous seasons made the team work.'

(3) Plakaty k zavtrašn-im debat-am / *debat-ov /
posters for tomorrow-DAT.PL debates-DAT.PL debates-GEN.PL

[2] Vasilyeva (2018) demonstrated that isolated syncretic forms are processed more slowly, unless they are syncretic between nominative and some other case — any form that can be understood as nominative is processed faster than the others.

*debat-ax vygljadeli ves'ma neobyčno.
debates-LOC.PL looked very unusual
'Posters for tomorrow's debates looked very unusual.'

Slioussar & Cherepovskaia showed that syncretic adjective forms create grammaticality illusions, i.e. make some errors more difficult to detect than others. For example, the genitive form in (2) provoked smaller reading time delays and more grammaticality judgment errors than the dative form because the locative plural adjective form is syncretic with genitive plural. In examples like (3), in which adjective forms were not syncretic, there were no differences between incorrect case forms. The last observation suggests that the factors that were found to influence Russian case form processing in isolation would not play a role in a sentential context. However, since this was not their goal, Slioussar & Cherepovskaia did not systematically compare different oblique cases. We set out to do so in the present study to identify all factors relevant for case processing in a sentential context.

4 THE PRESENT STUDY

We conducted two reading experiments comparing different case forms in sentential contexts in which different cases were required (for the sake of homogeneity, we always used prepositions to create such contexts). Only one case form was grammatically correct in each target sentence, and we expected that it would be read significantly faster than the others. Our goal was to find out whether there would be any differences between incorrect forms and, if yes, whether they would be associated with the same factors that were identified in the studies of isolated form processing, or with some other factors.

4.1 EXPERIMENT 1

4.1.1 PARTICIPANTS

42 native speakers of Russian aged 24–32 (6 male, 36 female) took part in Session 1, and 55 native speakers of Russian aged 19–35 (24 male, 31 female) took part in Session 2 on a voluntary basis. No participant took part in more than one experiment. All experiments reported in this paper were carried out in accordance with the Declaration of Helsinki and the existing Russian and international regulations concerning ethics in research. All participants provided informed consent.

4.1.2 MATERIALS

80 target sentences were constructed, each containing a preposition requiring a particular case: genitive, dative, accusative, or instrumental.[3] We used prepositions *iz* 'of' and *u* 'near' that assign genitive, *k* 'to' and *po* 'along' that assign dative, *pro* 'about' and *čerez* 'through' that assign accusative and *s* 'with' and *nad* 'over' that assign instrumental. Examples are given in (4)–(7). All sentences had the same syntactic structure and were presented in four experimental conditions: the target noun following the preposition could be in genitive, dative, accusative, or instrumental singular (only one form was grammatically correct). All target nouns were feminine, belonged to the 2nd declension and had a non-palatalized stem-final consonant so that they all had the same inflections (see Table 1).

(4) Desert iz malin-y / *malin-e / *malin-u /
dessert of raspberry-GEN raspberry-DAT=LOC raspberry-ACC
*malin-oj soderžit mnogo vitaminov.
raspberry-INS contains many vitamins
'The dessert with raspberry contains a lot of vitamins.'

[3]The experiment was very long, so we decided not to include locative.

(5) Priprava k ryb-e / *ryb-y / *ryb-u / *ryb-oj byla očen' ostroj.
sauce to fish-DAT fish-GEN fish-ACC fish-INS was very spicy
'The sauce for the fish was very spicy.'

(6) Fil'm pro balerin-u / *balerin-y / *balerin-e /
movie about ballerina-ACC ballerina-GEN ballerina-DAT=LOC
*balerin-oj vyzval interes zritelej.
ballerina-INS excited interest viewers
'The movie about the ballerina excited the interest of viewers.'

(7) Braslet s biruz-oj / *biruz-y / *biruz-e /
bracelet with turquoise-INS turquoise-GEN turquoise-DAT=LOC
*biruz-u sprjatan v škatulke.
turquoise-ACC is-hidden in jewelry-box
'The bracelet with turquoise is hidden in the jewelry box.'

All Russian nouns have syncretic forms both in singular and in plural. In most paradigms, accusative coincides either with nominative or with genitive. We were interested in analyzing accusative separately, so for our first experiment, we chose the 2nd declension, in which accusative forms are not syncretic, but dative and locative coincide in singular (see Table 1). When glossing the examples, we indicate affix syncretism for incorrect forms, but not for correct forms. In (5), it is obvious that the form ending in *-e* is interpreted as dative because the preposition requires dative. How the form ending in *-e* is interpreted in (4), (6) or (7) is an open question.

In addition to that, in this declension genitive singular has the same affix as nominative plural and, in inanimate nouns, as accusative plural. In some nouns, these forms are fully syncretic, while in the others, they have the same spelling, but different stress (e.g. *mámy* 'mother.GEN.SG=NOM.PL', *škóly* 'school.GEN.SG=NOM.PL=ACC.PL', *sosný* 'pine.GEN.SG', *sósny* 'pine.NOM.PL=ACC.PL'). Therefore, we used only animate target nouns with accusative prepositions, so that an ungrammatical genitive form in the sentences like (6) could not coincide with a grammatical accusative plural form. With other prepositions, both animate and inanimate target nouns were used.

The experiment was long, so it was run in two sessions. Session 1 included sentences with prepositions requiring genitive and dative, and Session 2 included sentences with prepositions requiring accusative and instrumental. In each session, there were 40 target sentences and 120 filler sentences. Target sentences were distributed across four experimental lists according to the Latin square principle, and filler sentences were the same in every list.

4.1.3 PROCEDURE

The participants performed a word-by-word non-cumulative self-paced-reading task (Just et al. 1982). Each trial began with a screen containing a sentence in which all letters were masked by dashes (spaces and punctuation marks were not masked). Each time the participant pressed the spacebar, a single word was revealed, and the previous word re-masked. Comprehension questions with a choice of two answers were asked after 30% of sentences to ensure that the participants were reading properly, for example: *Which sauce was spicy?* a. *the sauce for meat* b. *the sauce for fish*. The experiment was run online on the Ibex Farm platform (http://spellout.net/ibexfarm, Drummond et al. 2016).

4.1.4 DATA ANALYSIS

We analyzed participants' question-answering accuracy and reading times in two regions: the target word and the word following it. No participant made more than 3 errors in comprehension questions, so all data were included in the analyses. Reaction times

(RTs) that exceeded a threshold of 2.5 standard deviations, by region and condition, were winsorized, i.e. equated to this threshold. In total, about 2% of the data were winsorized.

We built linear mixed-effects models (LMM) using the *lme4* package (Bates et al. 2015) in the R software (www.r-project.org) to assess the effect of case on reading times. The *lmerTest* package (Kuznetsova et al. 2017) was used to estimate the *p* values. Random intercepts by participant, by target lexeme and by target wordform were included in the models. Random intercepts by target lexeme cover possible differences among stimuli associated with lexical effects (e.g. animacy, lexeme frequency) and with differences between the sentences containing target nouns. Random intercepts by target wordform cover possible differences related to wordform properties (e.g. their frequency and length).[4] To achieve the normality of model residuals, we applied a reciprocal transformation to RTs (Masson et al. 2017). For post hoc pairwise comparisons between different experimental conditions, Tukey's tests were conducted using the *glht* function from the *multcomp* package (Bretz et al. 2010).

Sentences with prepositions requiring different cases (genitive, dative, accusative and instrumental sets) and RTs in the target and post-target regions were analyzed separately. Thus, for every set in the two regions, we had one independent variable (case) with four levels (one correct form and three incorrect ones), coded as a treatment contrast. Firstly, the correct form was taken as the reference level. In the second comparison (including three incorrect forms), the case that was the first alphabetically served as the reference level. Thirdly, two remining incorrect forms were compared. According to Bonferroni correction, the p value was adjusted to 0.016.

4.1.5 RESULTS AND DISCUSSION

Mean RTs in target and post-target regions are shown in Figures 1 and 2.

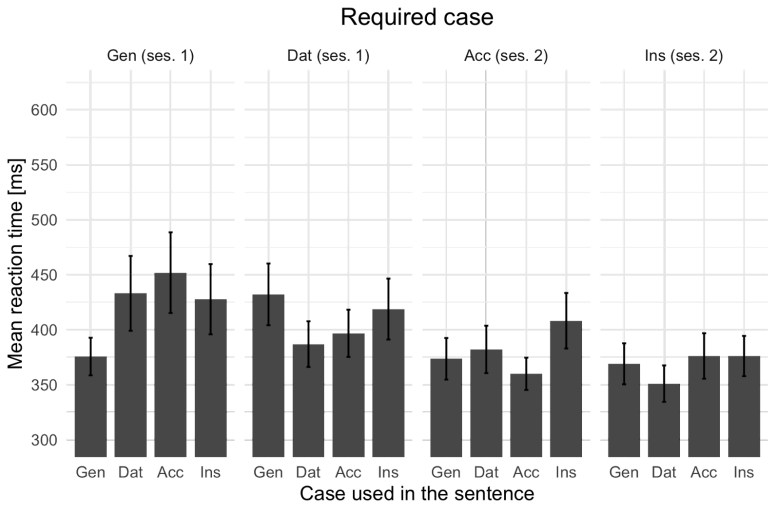

Figure 1: Experiment 1. Mean RTs in the target region.

In all sentence sets, incorrect forms had longer reading times than correct forms, as expected (for all significant results discussed below, model outputs are presented in Table 4.1.5). The differences were more pronounced in the post-target region than in the target region, which is typical for the self-paced reading paradigm (Witzel et al.

[4]Instrumental forms are always one letter longer than other forms used in our experiments. However, as we will see below, they were not read slower than other forms because of that. It would be great to include frequency of individual target noun forms as a separate factor in the models, but we do not have reliable form frequency counts for most Russian nouns. Nevertheless, we can be sure that for the absolute majority of nouns, genitive and accusative are more frequent than other oblique cases.

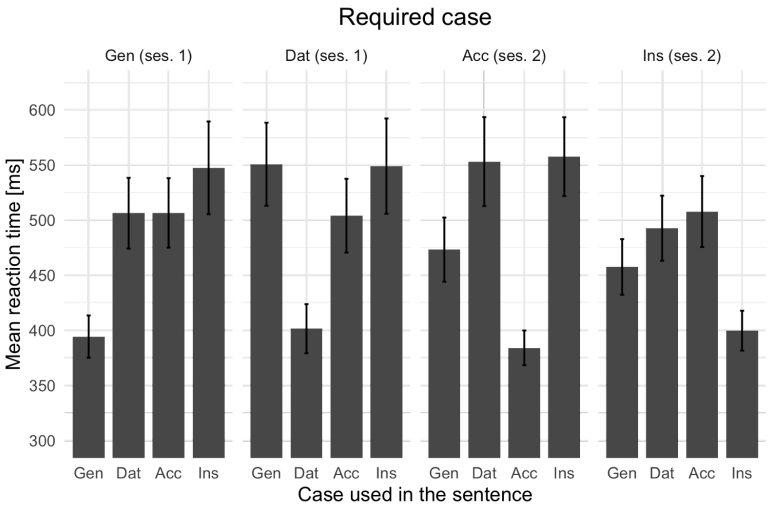

Figure 2: Experiment 1. Mean RTs in the post-target region.

2012). In the post-target region, all comparisons between correct and incorrect case forms gave significant results. In the target region, only in the genitive set were all comparisons significant. In the accusative and dative sets, only one comparison reached significance: correct accusative forms were faster than instrumental forms and correct dative forms were faster than genitive forms. In the instrumental set, there were no significant differences.

Set	Comparisons	Region	Model outputs
Genitive	Gen vs. Dat	target	β=0.08, SE=0.03, t=2.45, p=0.015
Genitive	Gen vs. Dat	post-target	β=0.43, SE=0.08, t=5.70, p<0.001
Genitive	Gen vs. Acc	target	β=0.09, SE=0.03, t=2.86, p=0.004
Genitive	Gen vs. Acc	post-target	β=0.41, SE=0.08, t=5.42, p<0.001
Genitive	Gen vs. Ins	target	β=0.08, SE=0.03, t=2.45, p=0.015
Genitive	Gen vs. Ins	post-target	β=0.50, SE=0.08, t=6.58, p<0.001
Dative	Dat vs. Gen	target	β=0.09, SE=0.03, t=3.46, p<0.001
Dative	Dat vs. Gen	post-target	β=0.59, SE=0.07, t=8.29, p<0.001
Dative	Dat vs. Acc	post-target	β=0.41, SE=0.07, t=5.63, p<0.001
Dative	Dat vs. Ins	post-target	β=0.48, SE=0.07, t=6.69, p<0.001
Accusative	Acc vs. Gen	post-target	β=0.35, SE=0.07, t=5.43, p<0.001
Accusative	Acc vs. Dat	post-target	β=0.50, SE=0.07, t=7.75, p<0.001
Accusative	Acc vs. Ins	target	β=0.21, SE=0.07, t=2.77, p=0.008
Accusative	Acc vs. Ins	post-target	β=0.59, SE=0.07, t=9.29, p<0.001
Instrumental	Ins vs. Gen	post-target	β=0.23, SE=0.06, t=3.83, p<0.001
Instrumental	Ins vs. Dat	post-target	β=0.32, SE=0.06, t=5.23, p<0.001
Instrumental	Ins vs. Acc	post-target	β=0.36, SE=0.06, t=5.90, p<0.001

Table 2: Experiment 1. Model outputs for RT analyses: correct forms vs. incorrect forms.

Now let us focus on comparisons between different incorrect forms. In the dative sets, accusative forms were read faster than genitive forms (β=0.07, SE=0.03, t=2.58, p=0.010 in the target region; β=0.19, SE=0.07, t=2.78, p=0.015 in the post-target region) and instrumental forms (β=0.04, SE=0.03, t=1.25, p=0.021 in the post-target region). In the accusative sets, genitive forms were read faster than instrumental forms (β=0.14, SE=0.08, t=2.42, p=0.041 in the target region; β=0.24, SE=0.07, t=3.50, p=0.001 in the post-target region) and dative/locative forms (β=-0.08, SE=0.03, t=-2.69, p=0.007 in the

post-target region). No other comparisons reached significance. In the instrumental and genitive sets, there were no significant results.

We can conclude that such factors as case frequency or case hierarchy that play a role in isolation did not affect the results. Accusative and genitive were not always processed faster than dative or instrumental (the latter are dramatically less frequent and lower in different case hierarchies). Instrumental forms that are one letter longer than other target forms were not read slower than all other incorrect forms either.

As far as we can judge, the observed pattern can be explained only by the trans-paradigmatic syncretism. Thus, *-y*, the affix of genitive singular in the 2nd declension, is used in accusative plural in many inanimate nouns.[5] The accusative singular affix -u is used in dative singular in the 1st declension. Apparently, these syncretic affixes created a mild grammaticality illusion, i.e. made certain errors more difficult to detect than the others

Let us also note that the affix *-e* is used not only in locative and dative, but also in nominative and accusative in neuter nouns, but this did not play a role in our experiment. This may be explained by the fact that it is used only with the stems ending in a palatalized consonant (see Table 1), while target nouns in our study had non-palatalized stem-final consonants. Since no previous studies had observed the effects of trans-paradigmatic syncretism in online processing, we conducted a second experiment to find out whether these effects would be replicated with a different group of target nouns.

4.2 EXPERIMENT 2

4.2.1 PARTICIPANTS

40 native speakers of Russian aged 18–26 (23 female) volunteered to take part in the study.

4.2.2 MATERIALS

For this experiment, we chose masculine animate target nouns from the 1st declension having a non-palatalized stem-final consonant. We could not mix animate and inanimate target nouns, as in Experiment 1, because they have different syncretism patterns: accusative is syncretic with genitive in the former and with nominative in the latter (see Table 1). We constructed 40 target sentences, each containing a preposition requiring dative or accusative (we limited ourselves to these two cases because they created the contexts in which the effects of trans-paradigmatic syncretism could be tested). In different experimental conditions, target nouns appeared in accusative (coinciding with genitive), dative, instrumental and locative, as examples (8–9) show.

(8) Pis'mo k brat-u / *brat-a / *brat-om / *brat-e
letter to brother-DAT brother-GEN=ACC brother-INS brother-LOC
poterjalos' na počte.
got-lost at post-office
'The letter to the brother got lost at the post office.'

(9) Basnja pro l'v-a / *l'v-u / *l'v-om / *l'v-e prozvučala so
fable about lion-GEN lion-DAT lion-INS lion-LOC sounded from
sceny.
stage
'A fable about the lion was told from the stage.'

In the dative set, we were interested to compare the locative form to the others: its affix *-e* is used in dative in the 2nd declension. In the accusative set, the dative form had the

[5] Remember that we used only animate target nouns in the accusative set, so they did not have this syncretism pattern in their own paradigms.

affix *-u* that is used in accusative in the 2nd declension. The materials also included 120 filler sentences and comprehension questions, as in Experiment 1. There were four experimental lists.

4.2.3 PROCEDURE AND DATA ANALYSIS

The procedure and data analysis were identical to those in Experiment 1. 4% of the data were winsorized as outliers.

4.2.4 RESULTS AND DISCUSSION

Mean RTs in target and post-target regions are shown in Figures 3 and 4.

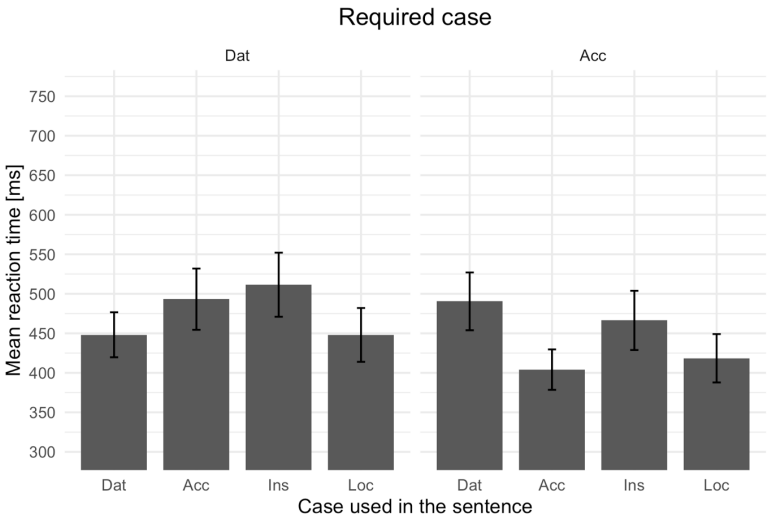

Figure 3: Experiment 2. Mean RTs in the target region.

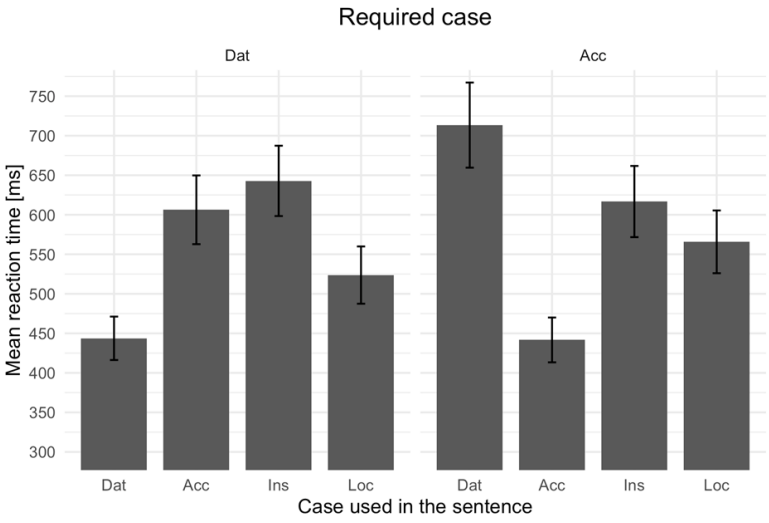

Figure 4: Experiment 2. Mean RTs in the post-target region.

As in Experiment 1, incorrect case forms were read more slowly than correct case forms both in the dative and in the accusative set (for all significant results, model outputs

are presented in Table 4.2.4).

Set	Comparisons	Region	Model outputs
Dative	Dat vs. Acc	post-target	β=0.54, SE=0.09, t=6.51, p<0.001
Dative	Dat vs. Ins	post-target	β=0.66, SE=0.09, t=7.81, p<0.001
Dative	Dat vs. Loc	post-target	β=0.28, SE=0.09, t=3.29, p=0.001
Accusative	Acc vs. Dat	target	β=0.40, SE=0.12, t=3.22, p=0.002
Accusative	Acc vs. Dat	post-target	β=0.77, SE=0.09, t=8.48, p<0.001
Accusative	Acc vs. Ins	post-target	β=0.54, SE=0.09, t=5.99, p<0.001
Accusative	Acc vs. Loc	post-target	β=0.39, SE=0.09, t=4.02, p<0.001

Table 3: Experiment 2. Model outputs for RT analyses: correct forms vs. incorrect forms.

Comparing incorrect case forms, we replicated the effect of trans-paradigmatic syncretism in the dative set. Locative forms (with the affix -e that is also used in dative) were read faster than genitive/accusative forms (β=-0.27, SE=0.09, t=-3.20, p=0.004 in the post-target region) and instrumental forms (β=-0.38, SE=0.09, t=-4.48, p<0.001 in the post-target region). In the accusative set, dative forms (with the affix -u that is also used in accusative) were also significantly different from the others, but in the opposite direction. They were read slower than locative forms (β=-0.35, SE=0.14, t=-2.58, p=0.027 in the target region; β=-0.39, SE=0.09, t=-4.16, p<0.001 in the post-target region) and instrumental forms (β=-0.22, SE=0.09, t=-2.43, p=0.040 in the post-target region). Like in Experiment 1, locative forms with the affix -e that is used in nominative and accusative of neuter nouns with palatalized stem-final consonants were not significantly different from other incorrect forms.

Therefore, Experiment 2 confirms our previous finding: the factors that affect noun form processing in isolation do not play a role in a sentence. It also confirms the role of trans-paradigmatic syncretism as a major factor. However, the reasons why trans-paradigmatic syncretism leads to shorter RTs in some cases and to longer RTs in the others should be elucidated.

5 GENERAL DISCUSSION

Processing of case forms has been studied in a variety of languages, but mainly in isolation. Comparing different forms of Russian nouns in a sentential context, we showed that the factors that had been previously identified for isolated forms (such as case frequency, position in different case hierarchies etc.) did not influence reading times. Instead, two other factors were significant: grammaticality, as expected, and trans-paradigmatic syncretism of case inflections. Several previous experiments demonstrated the role of intra-paradigmatic syncretism, for example, in the production and processing of agreement attraction errors (e.g. Badecker & Kuminiak 2007, Hartsuiker et al. 2003, Slioussar 2018, Slioussar & Makarova 2022). However, the effects of trans-paradigmatic syncretism have never been reported before.

Interestingly, trans-paradigmatic syncretism is known to play a role in language acquisition. Children acquiring Russian as their native language make relatively few case errors, and the largest share of these errors consist in using an affix from the wrong inflectional class (e.g. Gvozdev 1948/1961, Voeikova 2011).[6] Apparently, this happens because inflectional class and grammatical gender are arbitrary properties of a noun, which makes them more difficult to acquire than case or number features. But once they are acquired, adult native speakers never make such errors — a large survey of naturally occurring errors can be found in Rusakova (2001, 2009).

[6]Second language learners also make such errors, although for them, these errors are less characteristic than selecting the wrong case (Rubinstein 1995a,b, Cherepovskaia et al. 2022). Cherepovskaia & Slioussar (2021) ran several experiments studying how native speakers and second language learners process such errors and found effects of trans-paradigmatic syncretism similar to those we observed.

The effects of trans-paradigmatic syncretism are interesting both for morphological processing models and for theoretical approaches to the Russian case system. One of the major questions in processing is whether word forms are decomposed into stems and inflectional affixes or are retrieved from memory as a whole (e.g. Baayen et al. 1997, 2011, Butterworth 1983, Marantz 2013, Taft 1979, 2004). Our results provide a strong argument in favor of morphological decomposition and, moreover, of a very independent status of inflectional affixes in the mental lexicon, showing that they are processed on their own, not only as a part of a word form. In particular, syncretic affixes were demonstrated to activate not only the feature set they are responsible for in the current form, but also — to a lesser extent, but enough to create significant reading time differences — other feature sets they are associated with.

Now let us turn to theoretical approaches to the Russian case system. As we showed in the introduction, only Müller (2004) has tried to account for trans-paradigmatic syncretism. However, our results do not support his model. Müller explains the fact that the affix *-u* is used in dative in the 1st declension and in accusative in the 2nd by its very low specificity. In other words, in his model, this affix is not associated with accusative or dative singular — rather, it is used in these forms because no other more specific affixes can be found. If this were true, we would not expect the effects we found: we need -u to activate specifically dative singular and accusative singular feature sets, not a much larger set compatible with other cases. Moreover, Müller's model does not account for the trans-paradigmatic syncretism of *-e*, but we registered significant RT differences associated with it in our study.

No other author has tried to provide a systematic account of trans-paradigmatic syncretism in Russian nouns, and we tend to think that at least some cases are indeed purely accidental, like the syncretism of *-u* mentioned above (other cases, like the syncretism of *-e*, may receive an explanation in different models). If it is completely accidental that *-u* encodes dative singular in some nouns and accusative singular in others (as well as 1st person singular in some verbs), our data are compatible with any approach, but more readily with those that do not involve extensive underspecification or overspecification. Müller's (2004) model discussed above can serve as an example of extreme underspecification, while Caha's (2008) approach, applied to Russian in Caha (2021), relies on overspecification.

Caha (2021) postulates the following hierarchy of Russian cases: nominative > accusative > genitive > locative > dative > instrumental. He argues that each case feature is a separate syntactic head, with nominative being the most embedded and instrumental the least embedded. When the first feature is added on top of the extended NP, we get nominative. When the second feature is merged on top of the first one, we get accusative, and so on. An instrumental affix spells out a combination of all case features.

It is not immediately clear how this approach can be applied to our data. Instrumental affixes do not activate all other cases, although they are supposed to contain all case features. Rather, we found that the affix *-u* activates dative singular and accusative singular feature sets, and so on. Let us also note that if trans-paradigmatic syncretism is accidental, it relies on the phonological identity of the affixes. Processing effects based on their phonological identity, rather than on their shared features undermine the theories downplaying the role of concrete morphemes.

Finally, although our study demonstrated that trans-paradigmatic syncretism plays a role in processing, it still needs to be explained why it triggered faster reading times in three conditions and slowed readers down in the fourth. We do not have a ready solution for this puzzle and can only make the following observation. Slioussar & Samoilova (2015) calculated frequencies of different grammatical features and inflections based on the Russian National Corpus (www.ruscorpora.ru). For syncretic affixes they counted how often they encode a particular feature set. Here are the figures for the three affixes from our study:

- *-u*: Dat.Sg in 28.7% of cases, Acc.Sg in 62.9% of cases (as well as some excep-

tional genitive and locative forms), slowing down when the preposition requires accusative (the most frequent option for this affix), speeding up when the preposition requires dative;

- *-e*: Dat.Sg in 9.7% of cases, Loc.Sg in 61.1% of cases (as well as some forms of neuter nouns ending in palatalized stem-final consonants and several exceptional Nom.Pl forms), speeding up when the preposition requires dative;
- *-y*: Gen.Sg in 45.5% of cases, Acc.Pl in 20.3% of cases (as well as Nom.Pl forms), speeding up when the preposition requires accusative.

Apparently, masculine nouns of the 1st declension with the dative affix *-u* are the only ones that triggered longer reading times. Maybe the fact that this affix is much more frequent in accusative singular forms of the 2nd declension (in which the majority of nouns are feminine) creates an impression that a gender error was made, rather than a mild case-related grammaticality illusion? If this explanation is on the right track, frequency does influence processing, not only in isolation, but also in a sentential context, but in a very different way. Further studies are necessary to answer this question.

There is also another problem that must be addressed in further studies. If we used target nouns with palatalized stem-final consonants in our experiments, they would have the affix *-i* in genitive singular that coincides with many affixes in the 3rd declension (see Table 1). Would this create significant RT differences and in what direction? We also hypothesize that the syncretism between the affix *-e* used in locative in the 1st declension, in dative and locative in the 2nd declension, and in nominative and accusative in 1st declension neuter nouns did not play a role in our experiments because the relevant neuter nouns must have a palatalized stem-final consonant, unlike our target nouns. If another experiment is conducted using target nouns with a palatalized stem-final consonant, will the results be different?

ABBREVIATIONS

ACC	accusative	NOM	nominative
DAT	dative	obl	oblique
GEN	genitive	PL	plural
gov	governed	SG	singular
INS	instrumental	subj	subject
LOC	locative		

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