From surface form to mental representation: A processing investigation of Russian numerical phrases

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Abstract

Russian nouns in numerical expressions appear in three different forms, depending on the numeral: nominative with the numeral 1, genitive singular with the paucal numerals 2-4, and genitive plural with the other numerals. Results from two experiments on the processing of Russian case/number marking suggest that the genitive singular used with the paucals is different from the genitive singular proper found in non-numerical contexts. The processing data presented in this paper provide new support to the idea that linguistic representations can be abstracted away from surface linguistic forms, and that a surface form and its underlying representation could potentially be very different. In real-time processing, speakers are very sensitive to the mismatch between the underlying representation and the surface form. The status of the form occurring with the paucal numerals has long been a challenging issue in Russian linguistics, and the new results add to the growing body of literature that makes use of online processing methodologies in addressing issues of linguistic theory and analysis.

\textsuperscript{1} Abbreviations: ACC—accusative, FEM—feminine, GEN—genitive, MASC—masculine, NEG—negation, NEUT—neuter, NOM—nominative, PL—plural, PRES—present, SG—singular.
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Linguists can access mental representations of language by studying surface forms; sound inventories, vocabulary, morphological marking, word order, and other visible patterns are essential cues to the symbolic mapping of language. However, surface forms are not necessarily identical or isomorphic to mental representations of language, since abstraction from actual tokens is a common and widespread phenomenon. Scope ambiguity provides a good example of such idealization and abstraction. In languages that allow scope ambiguity, one surface word order leads to two different interpretations, depending on the order of the two scope elements at the abstract level (as represented, for example, by Logical Form—cf. May 1993). For example:

(1) A critic enjoyed every movie

i. “There was a particular critic who enjoyed every movie.” (*critic > movie, surface scope, isomorphic interpretation*)

ii. “For every movie, there was a critic who enjoyed it.” (*movie > critic, reverse scope, non-isomorphic interpretation*)

Thus, speakers’ mental representations are sometimes very different from, or even opposite to, what the surface form suggests (e.g., when the inverse scope reading is intended, in (1-i)).

How do speakers process representations that are different from the surface strings? Previous work on resolving scope ambiguities has suggested that both children and adults can access the non-isomorphic interpretation when the relevant contextual factors are controlled (Musolino & Lidz 2003; Paterson, Filik & Liversedge 2008). Note that in the case of scope ambiguity, both isomorphic and non-isomorphic representations are grammatical, and previous research has been aimed at revealing speakers’ preference. Little is known about cases when the...
surface and underlying representations are completely mismatched, without ambiguity as in scope. Such a mismatch is at the heart of the case we explore in this paper: the processing of Russian numerical expressions that involve a mismatch between surface and underlying representations, but without ensuing ambiguity.

Our test case is the morphology of nouns in Russian numerical expressions. Nouns in these expressions present an intriguing morphology-semantics mismatch which makes it difficult to maintain an isomorphic mapping. In the absence of isomorphic mapping, the processing results suggest that people are indeed sensitive to the underlying representation (which they access online), rather than merely to the surface form. The complicated case/number morphology of nouns in Russian numerical expressions has been addressed in several theoretical accounts; the study presented here will help us distinguish between these competing theoretical accounts. In our view, this is a compelling illustration of the value of experimental data in settling theoretical disputes. Finally, we hope that this study will stimulate interest in the morphology-semantics interface, which has been discussed less than the syntax-semantics interface.

2. Case and number morphology in Russian

In this section, we present the background on Russian case and number morphology, and survey the existing approaches to the Russian genitive, which lead to different predictions concerning the processing of case and number markers.

2.1. The puzzle of the genitive singular

Case and number in Russian are realized morphologically on the noun as a synthetic suffix (which also contains declension class information)\(^1\). In the current discussion, our main focus is on nouns in a numerical context - namely, nouns that are preceded by a numeral. The numerical
phrase has the reading of a precise quantity. Based on the surface marking of the noun in the numerical phrase, such phrases can be divided into three groups (we only consider numerical expressions in the nominative). When the numeral is ‘one,’ the noun following it appears in the (nominative) singular, and the numeral shows gender agreement with the noun. When the numeral is a number from 2 to 4, the following noun appears in the genitive singular. The numeral 2 (but not 3 or 4) shows gender agreement with the noun. For the numerals 5 and above, the following noun is marked as genitive plural, and there is no agreement in gender. The following examples illustrate these three patterns, for each gender (feminine, masculine, and neuter):

(2) odin-Ø mal’čik-Ø/ odn-a devočk-a/ odno jablok-o
    one-MASC boy-NOM.SG/ one-FEM girl-NOM.SG/ one-NEUT apple-NOM.SG
    ‘one boy, one girl, one apple’

(3) tri mal’čik-a/ tri devočk-i/ tri jablok-a
    three boy-GEN.SG/ three girl-GEN.SG/ three apple-GEN.SG
    ‘three boys, three girls, three apples’

(4) šest’ mal’čik-ov/ šest’ devoček/ šest’ jablok
    six boy-GEN.PL/ six girl-GEN.PL/ six apple-GEN.PL
    ‘six boys, six girls, six apples’

All numerical phrases starting with 2, 3, or 4 are categorized as plural, which is reflected in their verbal agreement (see also Ionin & Matushansky 2006), e.g.:

(5) dva mal’čik-a spjat/*spit
    two boy-GEN.SG sleep.PL/sleep.SG
    ‘Two boys are asleep.’
On the surface, the pattern in (3) is puzzling. Being conceptually plural, and being able to trigger plural agreement, as in (5), “three boys” is marked as genitive singular. In contexts without a numeral, the same form is only used with singular nouns, as shown by the following examples:

(6) a. obligatory genitive of negation (complement of a negative existential predicate)

net/ne okazalos’

be.NEG.PRES/not appeared.PAST.SG.NEUT

boy-GEN.SG/boy-GEN.PL

‘There is no boy./No boy appeared.’//‘There are no boys./No boys appeared.’

b. prepositional genitive

{do, u, bez, za} mal’čik-a/mal’čik-ov

to, by, without, instead of boy-GEN.SG/boy-GEN.PL

c. possessive genitive

sobaka mal’čik-a/mal’čik-ov

dog boy-GEN.SG/boy-GEN.PL

‘the boy’s/boys’ dog’

Next, the use of the genitive singular with the numerals 2-4 is only visible when the numerical phrase is in the nominative case, and, in the case of inanimate nouns, in the accusative case:

(7) a. priexali tri mal’čik-a

arrived.PL [three boy-GEN.SG],NOM

‘Three boys arrived.’
b. ja kupil tri apel’ sin-a

1SG bought [three orange-GEN.SG],ACC

‘I bought three oranges.’

In this paper, we will only be concerned with these contexts because they make the special
genitive visible. In what follows, we will refer to the lower numerals 2-4 as \textit{paucal} numerals,\textsuperscript{4} and to the genitive singular in those contexts as the \textit{“mystery form.”}

2.2. Main theoretical approaches to the “mystery form”

There are two possible ways to approach the singular marking in paucal contexts. One possibility is that the inflectional suffix on the noun is the phonological realization of a morpheme specified for the case and number features \{gen\} and \{+sg\}, respectively. Such an approach would treat these nouns as singular, and their suffixes as the same formal elements that appear in the contexts of the prepositional and possessive genitive, and the genitive of negation. The mismatch between the singular morphological marking and the non-singular semantics, then, needs a different explanation. The other possibility, however, is to treat the suffix on nouns following paucal numerals as simply syncretic, with a suffix that realizes a \{gen,+sg\} morpheme in the familiar environments. Under such a view, the featural composition of this suffix is different from \{gen,+sg\}, and there is no morpho-semantic mismatch. Both types of conceptions have been proposed in the literature.

2.2.1. “What you see is what you get”

Pesetsky (2007) treats nouns that appear with paucal numerals as underlingly singular. According to his analysis, nouns in Russian enter the syntactic derivation already containing a
suffix, which gets realized as genitive singular morphology. It is this suffix which, when attached to a stem, categorizes it as a noun.

Under this view, the form of the noun that we have so far identified with GEN.SG is the morphological realization of an underlyingly genitive singular noun. In other words, this form of the noun is the least marked (possibly equivalent to the lexical entry for the noun), and is merged with the small numerals. It is then the numeral itself that pluralizes the noun, by syntactically merging with it (for the details of this proposal, and the various questions that it raises, as well as possible answers, see Pesetsky 2007). The difference between noun phrases that contain the paucal numerals, and those that contain higher numerals, is illustrated in (8). Nouns in paucal contexts receive the plural feature only after they combine with the numeral. On the other hand, nouns in higher numeral contexts are pluralized pre-syntactically (in the morphology), before they combine with the numeral and enter the syntax with the feature [+pl] on them.

(8) a. paucal numerals                     b. numerals 5+

This account also maintains that the combination of a higher numeral and a noun is more complex, cf. (8b). However, as Pesetsky acknowledges, this dichotomy of feature assignment before or during the derivation has to remain a stipulation (Pesetsky 2007). This stipulation is motivated by the distinction between the genitive singular, which represents the base form of a noun, and the other case forms, which are lexical affixes added on to the base form.
2.2.2. The underlying form is not Gen.Sg.

Another family of accounts treats the nouns that appear with the paucal numerals as underlingly non-singular. Under the non-singular approach, there is no actual morpho-semantic mismatch, since the surface paucal suffix is simply syncretic with the \([\text{gen},+\text{sg}]\) morpheme. Within the family of non-singular analyses, proposals differ as to what the exact featural composition of the paucal morpheme may be. Some analyses assume that Russian morphosyntax makes reference to a third number category, distinct from singular and plural: paucal. Under this analysis, the paucal suffix (Gen.Sg. morphology) is in fact \([\text{nom},+\text{pauc}]\) (or \([\text{nom},-\text{sg},-\text{pl}]\); see Bailyn and Nevins 2008, Rakhlin 2003, Rappaport 2002). A similar approach is adopted by Ionin and Matushansky (2004, 2006), who explicitly state that the surface form and the underlying representation are different.

On this type of account, Russian—like Polish, Czech or Serbo-Croatian (Franks 1994, 1995, 1998, 2002)—in fact has a three-way distinction in marking its number morphology: singular, paucal, and plural. In this analysis, the form co-occurring with the numeral 1, and the forms co-occurring with the paucal numerals are consistent in their marking: they bear the nominative case and the appropriate number features. It is the genitive plural, which occurs with the numerals 5 and up, that requires an explanation. Very informally, this explanation is generally couched in terms of partivity: the plurality of entities is in theory infinite, and any specific number picks out a part of it, which motivates the use of genitive, which has the partitive semantics.

In a different version of the account that treats the “mystery form” as non-singular, Zaliznjak (1967) offers the following view: the “mystery form” is a special count form, which is outside of the nominal case paradigm. This puts this form on par with such Russian forms as
večerom ‘in the evening’ (historically, the instrumental form of večer), domoj ‘homeward’ (historically a form of dom ‘house, home’), or bez sprosu ‘without permission.’ These forms have the appearance of case forms, but they are not part of the general case paradigm of a respective noun. According to this view, nouns in the “mystery form” are simply count forms, and this makes them essentially caseless, in terms of morphological case, which means that they are neither [nom] nor [gen]. As far as their number is concerned, Zaliznjak suggests that they may be underspecified for number, which makes them compatible with numerals. However, it is not entirely clear, on this account, why these forms can only appear with paucal numerals, and get replaced by the genitive plural with numerals 5 and above (for example, in the related Bulgarian, the relevant ‘count form’ is used with all numerals above 1, e.g., dva/pet prozoreca ‘2/5 windows’).

2.3. Predictions for processing

Online sensitivity to mismatches in underlying representations is well-established in the processing literature. For instance, self-paced reading studies have consistently found that participants take longer time to read ungrammatical sentences that deviate from their grammatical representations. This observation will be the starting point for the studies presented here. In the case of the Russian numerical expressions, we predict that when the numerical context involves the number ‘one’, or a number greater than 4, native speakers of Russian will also show sensitivity to grammaticality. Namely, in these two environments, reading time (RT) on ungrammatical forms will be longer than on the grammatical ones.

We want, however, to make an important distinction that may have seemed trivial in previous studies on grammaticality detection. During online reading, as subjects are reading in a word-by-word incremental fashion, the grammaticality of the linguistic input is assessed at every
moment in time on at least two different levels of representation: an underlying representation of feature composition; and a surface phonological realization of that feature composition. To illustrate, let’s take an example from the current study. As the stimuli in Table 1 below show, subjects encounter numerical phrases such as $pjat’ \ldots mal’čikov$ ‘five … boys’. At the point when our participants read $mal’čik-ov$ ‘boy-Gen.Pl.’ following the numeral $pjat’$ ‘five,’ they might go through the following process of grammaticality checking. First, the parser is composing the structural features of the sentence, and at this point is therefore expecting the feature bundle $[+Gen,+Pl]$ on the noun. Second, in constructing the phonological representation of the noun, the parser is also expecting a “Gen.Pl” form. Finally, the actual linguistic input $mal’čik-ov$ ‘boy-Gen.Pl.’ is evaluated against the two expectations, and is judged to be acceptable. However, if the input at this juncture is something else—for instance, $mal’čik-Ø$ ‘boy-Nom.Sg’—this is judged unacceptable, given that the form does not meet the grammatical expectations at the structural or phonological level.

When the levels of representation are isomorphic, it is difficult to tease apart their demands. For many studies in the processing literature, it is also the case that a particular research question does not require a clear distinction between the two. However, we have good reasons to believe that both levels of representation, structural and phonological, should play a role in processing. One piece of evidence for separating the processing of surface and underlying forms comes from the research on processing irregular part tense forms. Researchers have argued that a verb form like $taught$ actually has an underlying representation of “teach+past.” The effect of the different levels of representation, including the underlying form, the surface phonological form, and the semantic representation, was observed separately in priming tasks (Stockall 2004, Stockall & Marantz 2006). More specifically, each of these representations demonstrated an independent facilitation effect, in priming other verbs with similar representations.
To return to the case of paucal nouns, for these forms it is yet to be determined whether the underlying representation and its surface phonological realization are isomorphic. Therefore, the distinction between the two in processing becomes crucial. If the underlying form is Gen.Sg., just like the surface phonological form, then paucal nouns are not different from nouns in other numerical contexts, in terms of the isomorphism between the underlying forms and the surface phonological realizations. We then expect to see the same kind of sensitivity to grammatical forms across nouns that follow different types of numerals.

On the other hand, if the underlying feature composition for paucal nouns is something other than \([+\text{gen}, +\text{sg}]\), we expect to see a decreased or diminished grammaticality effect. The logic is as follows. At the point when the paucal noun is read, the parser expects an underlying representation that is NOT \([+\text{gen}, +\text{sg}]\), but a phonological form that is Gen.Sg. The actual linguistic input they receive is a noun in the Gen.Sg. This form is only a good match at the level of phonological forms, but not the underlying representation. The parser will, in the end, accept it as grammatical, because it is indeed the grammatical form stored in native speakers’ memory. But we assume that the partial conflict between the expectation and the actual input will increase the processing cost, and hence narrow the gap one normally observes between grammatical and ungrammatical forms.

3. The experiments

Below, we present results from two experiments. In Experiment 1, we collected native speakers’ acceptability judgment data in an offline task. This experiment allows us to establish the basic judgments for the relevant Russian forms. In Experiment 2, we collected subjects’ online response to (un)grammatical forms in a self-paced reading task. It is in the second online experiment that we may expect to see the divergence (if any) of the paucal contexts from the
other two environments. The two experiments shared the same material, and were run on the same group of participants. Therefore, we introduce the material and procedure for both studies in the same section, below.

3.1. Materials

For both experiments, we had a total of 12 conditions, from a 3 x 4 design based on 2 independent variables. The first variable is the type of numerical context. Subjects read sentences that either have the number 1, paucal numbers (2 to 4), or numbers above 4.

The second variable we manipulated involved the degree of the match between the number-case marking on the noun, and the grammatical expectation in a given numerical context. For instance, following the number 1, speakers should expect a noun in the nominative singular. Therefore, a noun that is indeed marked as Nom.Sg will fully match the grammatical expectations, in terms of both number and case features. However, a noun that is marked as Nom.Pl. will only match the grammatical expectation on case marking, but not the number feature. Similarly, a noun marked as Gen.Sg. only matches the grammatical version in its number feature, but not in the case feature. Finally, a noun marked Gen.Pl. does not match any feature of the grammatical version.

For each of the three numerical contexts, the nouns following the numeral varied in 4 different ways, namely: full match, case match only, number match only, and no feature match. In order to avoid a parsing strategy that maps a numeral-noun sequence into a counting routine, we inserted an adjective between the numeral and the noun. The adjective also matches with the numeral in terms of its number and case features, and we always used the grammatical form of the adjective. Similarly, for the matrix verb of the sentence, we likewise only used the
grammatical form which matches the numerical context. In Table 1, we give an example of the experimental stimuli.

Table 1: Example Stimuli

<table>
<thead>
<tr>
<th>PP</th>
<th>Numeral</th>
<th>Adjective</th>
<th>Noun</th>
<th>PP</th>
<th>Verb</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>v xore</td>
<td>Odin</td>
<td>malen'kij</td>
<td>mal'čik (boy.NOM.SG)</td>
<td>PP</td>
<td>stojal</td>
<td>PP</td>
</tr>
<tr>
<td>in choir</td>
<td>one.NOM</td>
<td>little.NOM.SG</td>
<td>*mal'čika (boy.GEN.SG)</td>
<td>stojali</td>
<td>stood.PL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>*mal'čiki (boy.NOM.PL)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>*mal'čikov (boy.GEN.PL)</td>
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<td></td>
</tr>
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<td></td>
<td>tri</td>
<td>malen'kix</td>
<td>*mal'čik (boy.NOM.SG.)</td>
<td>v očkax</td>
<td>in glasses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>three.NOM</td>
<td>little.PL.GEN</td>
<td>mal'čika (boy.GEN.SG)</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>*mal'čiki (boy.NOM.PL)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>*mal'čikov (boy.GEN.PL)</td>
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</tr>
<tr>
<td></td>
<td>pjat'</td>
<td>malen'kix</td>
<td>*mal'čik (boy.NOM.SG)</td>
<td>stojali</td>
<td>stood.PL</td>
<td></td>
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<tr>
<td></td>
<td>five.NOM</td>
<td>little.PL.GEN</td>
<td>*mal'čika (boy.GEN.SG)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>*mal'čiki (boy.NOM.PL)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>*mal'čikov (boy.GEN.PL)</td>
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</tr>
</tbody>
</table>

‘In the choir, one/three/five boys in glasses stood in front of everybody.’

There are a total of 60 experimental items, and each appears in the 12 conditions described above. These sentences are distributed into 12 lists, under a Latin Square design. Within the experimental items, the grammatical/ungrammatical ratio is 1:3. In addition, there are 108 filler sentences, which include some ungrammatical sentences. The overall grammatical/ungrammatical ratio in the entire stimuli set is 7:5. Our stimuli include 29 animates and 31 inanimates. In order to minimize case syncretism, we used only masculine nouns, because they show the cases required by the numerals most clearly. In particular, we avoided feminine nouns, given that they exhibit identical nominative plural and genitive singular forms.

3.2. Participants and Procedure

37 native Russian speakers from Moscow, Russia, and the Boston area, USA, participated in our experiment. There were 27 females, 9 males; average age 28; those participants who were tested
in the USA had been in outside Russia on the average 3.5 years. All the subjects were reimbursed for participation. They completed the self-paced reading task first. Sentences were presented using the Linger Software package (Rohde 2003) on a PC. Participants press on the space-bar in order to proceed reading, in a word by word fashion. Following 1/3 of the sentences, there was a yes-no question for the participants to answer, concerning the content of the immediately preceding sentence. Results from their accuracy data show that the average accuracy is 89%, with every participant having an accuracy rate of 80% and above. Nobody was excluded from the data analysis in the result section below.

After they finished the self-paced reading task, the subjects were asked to complete an acceptability judgment task. 35 participants from the 37 people above finished the acceptability judgment task. All of the stimuli in the judgment task, including the experimental items and fillers, are the same as in the self-paced reading (except that there were no yes-no questions in the rating task). Participants were tested individually, in a quiet room. Each was given a pencil and a printed copy of the sentences. The task is to rate each sentence on a 1 to 7 scale. 1 represents a completely unacceptable sentence, and 7 represents a fully acceptable one. The participants were instructed to make the judgments based on their intuitions, rather than any prescriptive rules acquired in classroom settings.

3.3. Rating experiment

3.3.1. Results

The average rating results are presented in figure 1.

[Figure 1] Acceptability Judgment
A 3 by 4 ANOVA shows no main effect of numerical context, but does show a main effect of feature match ($F_1(3, 102)=81, p_{1}<.001$; $F_2(3, 177)=220, p_{2}<.001$). The interaction is significant by subject only ($F_1(6, 204)=2.9, p_{1}<.01$; $F_2(6, 354)=1.2, p_{2}>.3$).

### 3.3.2. Summary

The offline acceptability judgment task confirmed the acceptability of the grammatical noun forms following the three different types of numerals. Namely, Nom.Sg., Gen.Sg, and Gen.Pl. are indeed the acceptable case/number markings on nouns in these numerical contexts. To find out how people respond to these grammatical forms under real time pressure, in the next section we present online data from the self-paced reading task.

### 3.4. Self-paced reading experiment

#### 3.4.1. Data Analysis

Self-paced RT results were examined word-by-word. Because of the large number of conditions in our experiment, rather than presenting RTs on each word of the sentence, for each condition, we will discuss only the three regions of interest around the critical noun: the word before the
critical N, the critical N itself, and the spill-over word after the critical N. RTs above 2000ms were removed from data analysis, which affected 3% of the data. For the rest of the RT data, mixed effect models were carried out for each region of interest, with subjects and items as random effects, and numerical context and feature match as fixed effects. This analysis allows simultaneous generalization to the population of participants and items, and can avoid potential spurious effects arising from the traditional ANOVA done on group averaged data (Baayen et al. 2008). Analyses were carried out using R, an open source statistical computing software (R Development Core Team 2008), and in particular the lme4 package for linear mixed-effect models (Bates et al. 2008).

3.4.2. Results

The word before the critical N

Figure 2 shows the RT for each condition at the adjective region before the critical N. Mixed effect models reveal no effect of either the numerical context, or the morphological marking on the N. We also found no interaction between the two. This is expected, given that at this region, all of the adjectives comply with the grammatical requirements imposed by the preceding numeral. In other words, no anomaly arises at this region yet.

[Figure 2] RT at the word before the critical N
The critical $N$

In Table 2 we present RT and the standard derivation (SD) for each condition at the critical N region. The RT at this region is also graphed in Figure 3.

Table 2 mean RT at the critical $N$

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>5+</th>
<th>paucal</th>
</tr>
</thead>
<tbody>
<tr>
<td>match.both</td>
<td>465(155)</td>
<td>489(146)</td>
<td>501(177)</td>
</tr>
<tr>
<td>match.case</td>
<td>540(219)</td>
<td>537(183)</td>
<td>521(212)</td>
</tr>
<tr>
<td>match.num</td>
<td>546(208)</td>
<td>538(198)</td>
<td>507(180)</td>
</tr>
<tr>
<td>match.zero</td>
<td>576(233)</td>
<td>517(168)</td>
<td>507(191)</td>
</tr>
</tbody>
</table>

[Figure 3] RT at the critical N
We again carried out mixed effect models for this region, with subjects and items as random effects. The ANOVA summary of the model reveals a main effect of morphological feature match ($F(3, 2156) = 4.2, p < .01$), but there is no difference among the three numerical contexts. There is also no interaction. The ANOVA summary of the model itself is presented in Table 3.

Table 3: ANOVA summary of the mixed effect model with subjects and items as random effects

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F</th>
<th>DF2</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>num.context</td>
<td>2</td>
<td>189704</td>
<td>94852</td>
<td>1.4197</td>
<td>2156</td>
<td>0.2420</td>
</tr>
<tr>
<td>fea.match</td>
<td>3</td>
<td>832603</td>
<td>277534</td>
<td>4.1539</td>
<td>2156</td>
<td>0.0061**</td>
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<tr>
<td>interaction</td>
<td>6</td>
<td>633308</td>
<td>105551</td>
<td>1.5798</td>
<td>2156</td>
<td>0.1490</td>
</tr>
</tbody>
</table>

Signif. codes: ‘***’ 0.001; ‘**’ 0.01; ‘*’ 0.05

To further locate the exact source of the significant effects, and also to compare the three types of numerical contexts, we also carried out mixed effect models separately for each numerical
context. For each model, we reported below two summaries, each with a different intercept, such that one can see all the relevant comparisons among different conditions.

[Table 4: Summaries for the mixed model of group 1 (numerical context: 1)]

[Table 4 a.]

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>MCMCmean</th>
<th>HPD95lower</th>
<th>HPD95upper</th>
<th>pMCMC</th>
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</thead>
<tbody>
<tr>
<td>(Intercept: nom.sg.)</td>
<td>465.82</td>
<td>465.83</td>
<td>398.33</td>
<td>534.8</td>
<td>0.0001</td>
</tr>
<tr>
<td>fea.match.case (nom.pl.)</td>
<td>71.13</td>
<td>70.65</td>
<td>13.42</td>
<td>128.0</td>
<td>0.0158*</td>
</tr>
<tr>
<td>fea.match.num (gen.sg.)</td>
<td>80.10</td>
<td>79.59</td>
<td>21.68</td>
<td>134.5</td>
<td>0.0048**</td>
</tr>
<tr>
<td>fea.match.zero (gen.pl.)</td>
<td>111.28</td>
<td>111.01</td>
<td>53.69</td>
<td>166.8</td>
<td>0.0001***</td>
</tr>
</tbody>
</table>

Signif. codes:   ‘***’ 0.001; ‘**’ 0.01; ‘*’ 0.05

[Table 4 b.]

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>MCMCmean</th>
<th>HPD95lower</th>
<th>HPD95upper</th>
<th>pMCMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept: gen.pl.)</td>
<td>577.10</td>
<td>574.94</td>
<td>505.17</td>
<td>643.94</td>
<td>0.0001</td>
</tr>
<tr>
<td>fea.match.both (nom.sg.)</td>
<td>-111.28</td>
<td>-107.16</td>
<td>-164.95</td>
<td>-50.25</td>
<td>0.0002***</td>
</tr>
<tr>
<td>fea.match.case (nom.pl.)</td>
<td>-40.15</td>
<td>-33.90</td>
<td>-89.36</td>
<td>26.34</td>
<td>0.2582</td>
</tr>
<tr>
<td>fea.match.num (gen.sg.)</td>
<td>-31.18</td>
<td>-31.58</td>
<td>-86.93</td>
<td>27.89</td>
<td>0.2810</td>
</tr>
</tbody>
</table>

These tables should be read as follows. In Table 4a, the intercept represents the RT for the match-both-features condition (nom.sg. in this case, 466ms). As can be seen from the Estimate column, the case-match-only condition takes 71ms longer, the number-match-only condition is 80ms longer, and the match-zero condition is 111ms longer. The corresponding p-values indicate that all of these differences are significant. In Table 4b, the intercept value represents the RT for the zero-match condition (gen.pl. in this case, 577ms). The Estimate column shows that the both-match condition was read 111ms faster, and the corresponding p-value shows that the difference
between the two is significant. The case-match-only condition was 40ms faster, and the number-match-only condition was 31ms faster, but neither is significantly different from the zero-match condition. Therefore, we see a difference between the grammatical form and the other three ungrammatical forms, but there is no difference between the three ungrammatical forms.

[Table 5: Summary for the mixed model effect for group 2 (numerical context: 5+)]

[Table 5a.]

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>MCMCmean</th>
<th>HPD95lower</th>
<th>HPD95upper</th>
<th>pMCMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept:gen.pl.)</td>
<td>489.19</td>
<td>489.00</td>
<td>430.4492</td>
<td>545.54</td>
<td>0.0001</td>
</tr>
<tr>
<td>fea.match.case (gen.sg.)</td>
<td>45.60</td>
<td>46.77</td>
<td>-4.6565</td>
<td>97.60</td>
<td>0.0728</td>
</tr>
<tr>
<td>fea.match.num (nom.pl.)</td>
<td>48.47</td>
<td>51.96</td>
<td>0.5854</td>
<td>103.13</td>
<td>0.0500</td>
</tr>
<tr>
<td>fea.match.zero (nom.sg.)</td>
<td>24.07</td>
<td>21.41</td>
<td>-29.4291</td>
<td>73.16</td>
<td>0.4140</td>
</tr>
</tbody>
</table>

[Table 5b.]

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>MCMCmean</th>
<th>HPD95lower</th>
<th>HPD95upper</th>
<th>pMCMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept:nom.sg.)</td>
<td>513.26</td>
<td>510.88</td>
<td>455.44</td>
<td>570.27</td>
<td>0.0001</td>
</tr>
<tr>
<td>fea.match.both (gen.pl.)</td>
<td>-24.07</td>
<td>-21.68</td>
<td>-72.13</td>
<td>28.27</td>
<td>0.4028</td>
</tr>
<tr>
<td>fea.match.case (gen.sg.)</td>
<td>21.53</td>
<td>25.03</td>
<td>-26.59</td>
<td>74.50</td>
<td>0.3380</td>
</tr>
<tr>
<td>fea.match.num (nom.pl.)</td>
<td>24.40</td>
<td>30.36</td>
<td>-19.47</td>
<td>83.72</td>
<td>0.2452</td>
</tr>
</tbody>
</table>

Signif. codes: ‘***’ 0.001; ‘**’ 0.01; ‘*’ 0.05

These tables are read in the same way as the tables above. When the numerical context is larger than 4, there is a trend in that the grammatical form (match-both-features condition) is read faster than all other ungrammatical forms. But the only significant difference is between the grammatical form and the form that is ungrammatical, but has correct number feature (number-match-only condition, p=.05). The form that is ungrammatical but has the correct case feature
(case-match-only condition) is marginally different from the grammatical one ($p=.07$). There is no difference between the grammatical form and the completely ungrammatical form (zero-match condition).

[Table 6 Summary for the mixed model effect for group 3 (numerical context: 2-4)]

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>MCMCmean</th>
<th>HPD95lower</th>
<th>HPD95upper</th>
<th>pMCMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept: gen.sg.)</td>
<td>499.923</td>
<td>500.112</td>
<td>438.93</td>
<td>561.93</td>
<td>0.0001</td>
</tr>
<tr>
<td>fia.match.case (gen.pl.)</td>
<td>20.879</td>
<td>20.366</td>
<td>-31.14</td>
<td>71.32</td>
<td>0.4466</td>
</tr>
<tr>
<td>fia.match.num (nom.sg.)</td>
<td>6.257</td>
<td>5.975</td>
<td>-45.98</td>
<td>56.48</td>
<td>0.8178</td>
</tr>
<tr>
<td>fia.match.zero (nom.pl.)</td>
<td>4.330</td>
<td>3.487</td>
<td>-48.57</td>
<td>55.21</td>
<td>0.8858</td>
</tr>
</tbody>
</table>

[Table 6b.]

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>MCMCmean</th>
<th>HPD95lower</th>
<th>HPD95upper</th>
<th>pMCMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept: nom.pl.)</td>
<td>504.252</td>
<td>503.821</td>
<td>439.57</td>
<td>566.08</td>
<td>0.0001</td>
</tr>
<tr>
<td>fia.match.both (gen.sg.)</td>
<td>-4.330</td>
<td>-3.303</td>
<td>-54.00</td>
<td>49.55</td>
<td>0.9060</td>
</tr>
<tr>
<td>fia.match.case (gen.pl.)</td>
<td>16.549</td>
<td>16.674</td>
<td>-35.61</td>
<td>69.32</td>
<td>0.5298</td>
</tr>
<tr>
<td>fia.match.num (nom.sg.)</td>
<td>1.927</td>
<td>2.203</td>
<td>-49.99</td>
<td>53.85</td>
<td>0.9314</td>
</tr>
</tbody>
</table>

Signif. codes: ‘***’ 0.001; ‘**’ 0.01; ‘*’ 0.05

With paucal numerals, there is no significant effect in any of the conditions.

**The spill-over region**

In Figure 4 we present RT for each condition at the spill-over region after the critical N. The mean RTs and standard derivations (SD) are presented in Table 7.
The ANOVA summary of the mixed model shows a main effect of morphological feature match (F(2, 2198)=5.5, p<.001), a main effect for numerical context (F(3, 2198)=10.5, p<.001), and also a significant interaction (F(6, 2198)=1.8, p<.001). A summary of the model is presented in Table 8.
As for the critical region, separate mixed models analyses were also carried out for each numerical context in the spill-over region.

[Table 9: Summary for the mixed model effect for group 1 (numerical context: 1), spill-over]

[Table 9a]

<table>
<thead>
<tr>
<th>Estimate</th>
<th>MCMCmean</th>
<th>HPD95lower</th>
<th>HPD95upper</th>
<th>pMCMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept: nom.sg.)</td>
<td>424.89</td>
<td>378.81</td>
<td>471.8</td>
<td>0.0001</td>
</tr>
<tr>
<td>fea.match.case (nom.pl.)</td>
<td>70.77</td>
<td>22.07</td>
<td>116.8</td>
<td>0.0030**</td>
</tr>
<tr>
<td>fea.match.num (gen.sg.)</td>
<td>79.45</td>
<td>31.28</td>
<td>125.9</td>
<td>0.0016**</td>
</tr>
<tr>
<td>fea.match.zero (gen.pl.)</td>
<td>86.16</td>
<td>36.94</td>
<td>129.9</td>
<td>0.0006***</td>
</tr>
</tbody>
</table>

[Table 9b]

<table>
<thead>
<tr>
<th>Estimate</th>
<th>MCMCmean</th>
<th>HPD95lower</th>
<th>HPD95upper</th>
<th>pMCMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept: gen.pl.)</td>
<td>511.054</td>
<td>464.07</td>
<td>557.95</td>
<td>0.0001</td>
</tr>
<tr>
<td>fea.match.both (nom.sg.)</td>
<td>-86.165</td>
<td>-130.54</td>
<td>-36.72</td>
<td>0.0004***</td>
</tr>
<tr>
<td>fea.match.case (nom.pl.)</td>
<td>-15.390</td>
<td>-59.68</td>
<td>35.42</td>
<td>0.5684</td>
</tr>
<tr>
<td>fea.match.num (gen.sg.)</td>
<td>-6.717</td>
<td>-50.89</td>
<td>41.53</td>
<td>0.8564</td>
</tr>
</tbody>
</table>
When the numeral is 1, the grammatical form was read significantly faster than the other three ungrammatical forms. There is no difference among the three ungrammatical forms.

[Table 10: Summary for the mixed model effect for group 2 (numerical context: 5+), spill-over]

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>MCMCmean</th>
<th>HPD95lower</th>
<th>HPD95upper</th>
<th>pMCMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept: gen.pl.)</td>
<td>413.86</td>
<td>414.07</td>
<td>368.54</td>
<td>458.95</td>
<td>0.0001</td>
</tr>
<tr>
<td>fea.match.case (gen.sg.)</td>
<td>59.93</td>
<td>60.42</td>
<td>15.65</td>
<td>103.73</td>
<td>0.0070**</td>
</tr>
<tr>
<td>fea.match.num (nom.pl.)</td>
<td>54.15</td>
<td>53.95</td>
<td>10.56</td>
<td>98.64</td>
<td>0.0166*</td>
</tr>
<tr>
<td>fea.match.zero (nom.sg.)</td>
<td>98.36</td>
<td>97.43</td>
<td>53.44</td>
<td>142.30</td>
<td>0.0001***</td>
</tr>
</tbody>
</table>

[Table 10b]

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>MCMCmean</th>
<th>HPD95lower</th>
<th>HPD95upper</th>
<th>pMCMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept: nom.sg.)</td>
<td>512.21</td>
<td>511.26</td>
<td>466.81</td>
<td>556.4443</td>
<td>0.0001</td>
</tr>
<tr>
<td>fea.match.both (gen.pl.)</td>
<td>-98.36</td>
<td>-97.45</td>
<td>-143.76</td>
<td>-56.2162</td>
<td>0.0001***</td>
</tr>
<tr>
<td>fea.match.case (gen.sg.)</td>
<td>-38.43</td>
<td>-37.02</td>
<td>-78.68</td>
<td>9.9155</td>
<td>0.1052</td>
</tr>
<tr>
<td>fea.match.num (nom.pl.)</td>
<td>-44.21</td>
<td>-43.30</td>
<td>-86.99</td>
<td>0.6109</td>
<td>0.0558</td>
</tr>
</tbody>
</table>

When the numeral is higher than 4, again we find that the grammatical form is read significantly faster than the other three ungrammatical forms. There is no significant difference among the three ungrammatical forms, but the RT for the number-match-only condition is marginally shorter than the zero-match condition (p=.06).
For the last group, with the paucal numerals, we did not find much difference among the 4 conditions. The only marginal significant difference is between the grammatical form and the number-match-only form (p=.052), with a 35ms longer RT on the number-match-only condition.

### 3.4.3. Summary of the self-paced reading experiment

To summarize, the self-paced reading study suggested different processing profiles for the three types of numerical contexts. When the numeral is 1, speakers’ RT showed sensitivity to grammaticality as early as at the critical noun. The grammatical form was read faster than all of the other (ungrammatical) forms. There was no difference between the ungrammatical forms, and this effect continued to the spill-over region. When the numeral is 5 or higher, there is no difference between the fully grammatical form and the fully ungrammatical form (zero-match) at
the critical noun. However, the partially matched ungrammatical conditions (with the correct number feature or correct case form) are significantly different from the grammatical condition. We will come back to this in the discussion section. At the spill-over region, the 5+ number context showed the same kind of grammaticality effect as the number 1 context—namely, the grammatical form was read faster than all other ungrammatical forms, and there was no difference among the three ungrammatical forms. With the paucal numerals, we did not find any robust difference between the grammatical condition and the ungrammatical conditions, either at the critical noun, or in the spill-over position. However, at the spill-over region, the ungrammatical condition with the matching number feature again showed significant difference from the grammatical condition.

The basic findings of the self-paced reading study are as follows. First, the paucal numeral context is very different from the other two numerical contexts, in the sense that speakers did not show any sensitivity to grammatically in this context, even though in the offline judgment study (Expt. 1) there was a clear preference for the grammatical form. Second, the number 1 context triggered responses to grammaticality at the critical noun, whereas the 5+ number context showed a delayed effect at the spill-over region. Third, whenever we see sensitivity to grammaticality, it appears to be categorical. If speakers clearly distinguished the fully grammatical and fully ungrammatical forms, the “intermediate” ungrammatical forms with partially matching features were treated exactly like the fully ungrammatical ones.
4. General Discussion

4.1. The “mystery form” in the paucal context is not genitive singular

The offline acceptability judgment task showed that native speakers are fully aware of the correct and incorrect forms that nouns take in different numerical contexts. There is no difference in their acceptability with respect to different numerals.

However, the online data reveal crucial differences: case/number violations in the paucal context do not evoke the same kind of grammaticality effect as the case/number violations in the two other numerical contexts. Had the subjects represented the “mystery form” as a true Gen.Sg., we should have observed the standard grammaticality effect, as found in the other two control contexts. The grammaticality effect would be expected at the critical noun, because this is the point at which the noun itself enters into the structural derivation. The lack of such a grammaticality effect strongly suggests that the underlying morphological representation is not Gen.Sg. This result, then, is inconsistent with Pesetsky (2007), which treats nouns in the “mystery form” in the paucal context, as a case of the true Gen.Sg. The current result is consistent with the other proposals, which treat the underlying representation of the “mystery form” as different from Gen.Sg.

If so, what is the underlying representation of the noun in the paucal context? Although the answer is tentative, we can offer some considerations. The answer comes from the spill-over region. Out of the three ungrammatical forms, the Nom.Pl and the Gen.Pl. show closer processing profiles in the spill-over region; not only are they closer to each other but they are also closer to the “mystery form” –which is grammatical. The only condition that is significantly different from the grammatical form is Nom.Sg. The feature that differentiates Nom.Sg. from the two other ungrammatical forms (Nom.Pl and Gen.Pl) is [-sg]. If the underlying representation of the
“mystery form” is also [-sg], we can explain why, among the three ungrammatical forms, only the [+sg] one is significantly different from the “mystery form”.

Recall that there are two proposals which offered the non-singular account of the “mystery form”: one claims that its true representation should be Nominative Paucal (Bailyn and Nevins 2008, Rakhlin 2003, Rappaport 2002), and the other treats it as a special count form without case features (Zaliznjak 1967). We do not find anything that would distinguish between the Nominative Paucal analysis and the count form analysis in the critical noun region. In the spill-over region, we find a numerical trend suggesting, if preliminarily, that the Nominative Paucal approach may be on the right track: of the three non-matching forms, the form of the nominative plural is processed slightly faster. We can attribute this to the fact that this form matches the the “mystery form” in two features, number and case:; they are both [-sg] and they are both represented underlingly as nominative.

In sum, the experimental data indicate that the “mystery form” is underlingly represented differently from its surface form, “Gen.Sg.” We conclude that the underling form is non-singular (which could be further specified as paucal), but that its actual case feature is not yet clear. Overall, these results are consistent with the mismatch between the surface form and the underling representation that we discussed in the introduction—there is no ambiguity (unlike scope structures), but the mismatch still takes its toll on processing.

4.2. The singular context advantage

Our study also found processing differences between singular and plural contexts. Comparing the context where the numeral is ‘one’, and the context where the numeral is a number higher than 4, we see that in the former context, speakers are faster in detecting morphological violations. The
grammaticality effect appeared at the critical noun for the singular number context, but was
delayed to the spill-over region for the 5+ number context.

At first glance, this result may seem unsurprising. It has been observed that singular and
plurals nouns are processed differently in a number of respects. Several lexical decision and self-
paced reading studies have found that surface frequency has an asymmetrical effect on processing
singular and plural forms (New et al. 2004; Lau et al. 2007). If a word is more frequently used in
its singular form (singular dominant words), using it in its plural form evoked more processing
cost. However, plural dominant words showed no significant difference between their singular
and plural forms. New et al. (2004) suggested that this asymmetry arises because singular nouns
are processed based on their base frequency, whereas both base and surface frequencies
contribute to the processing of plural nouns. Wagers et al. (2009) reported that when a noun is
separated from its mismatched number-specific demonstrative (e.g., this...apples and
these...apple), increasing the distance between the demonstrative and the noun only slows down
the retrieval of the demonstrative for the singular noun conditions, but not for the plural ones.
Wagers et al. argued that at least in English the plural feature on nouns is marked, and the
singular feature is unmarked. Because of this difference in markedness, when people process the
number-specific demonstrative this/these, an expectation for [+plural] nouns is generated, and
carried forward in the plural context (these), but no expectation is generated for [+singular] nouns
in the singular context (this). As a result, at the noun, less processing cost is needed to retrieve the
plural demonstrative, since the [+plural] feature has always stayed in the focal attention of the
working memory.

The difference we observed in our study is also likely to be due to the difference
between the Nom.Sg. and Gen.Pl. in morphological markedness. For the masculine nouns, the
Nom.Sg. form is the least marked form in the case/number paradigm, as its exponent is
commonly a morphologically null form, cf. the form *mal’čik-Ø* ‘boy.’ On the other hand, Gen.Pl. has three different morphological realizations, depending on the stem (cf. Zaliznjak 1967, 1977, Jakobson 1984). People could react faster to the morphological violations when they error-check a less complex form, or a form that has few potential exponents. It may be that it simply takes longer time, and more processing effort, to detect an error on a morphologically more marked form.

4.3. **Gradience effect**

Recall that in the experimental stimuli, each grammatical form is compared with three types of ungrammatical forms. The ungrammatical form either has only one case or number feature incorrect, or has both features incorrect. This was designed to test whether violations of different case or number features, and the number of feature violations, will lead to different degrees of grammaticality violation, such that some ungrammatical forms are “more ungrammatical” than others, or that more feature violations lead to a higher degree of unacceptability.

Gradient acceptability has been reported for word recognition in sentential context. In studies addressing these contexts, word recognition is facilitated because the semantic features of the target word have been activated in advance, through prediction from sentential context. But crucially for our interest, the facilitation effect is not only found for the target word that best fits the discourse context, but also for words that share semantic features with the best-fit word, even if these semantically related words, strictly speaking, do not fit in the sentential context (Kleiman 1980, Kutas & Hillyard 1984, Federmeier & Kutas 1999). In other words, one often finds gradient effect among the expected target, an unexpected but semantically related target, and the unexpected and also unrelated target. For instance, in an ERP study, Federmeier and Kutas (1999) reported that in a context where people are expecting the target word *palms* (such as in the
They wanted to make the hotel look more like a tropical resort. So along the driveway, they planted rows of palms. Federmeier and Kutas suggested that this is due to more semantic feature overlap between palms and pines (e.g. they are both from the same semantic category of trees).

It is not clear from the literature, however, if processing grammatical features also presents a pattern of graded acceptability. Taking agreement processing as an example, one can imagine two possibilities. The parser could signal absolute ungrammaticality, as long as one feature value is mismatched. On the other hand, the parser could also keep track of each individual feature, and signal different degrees of ungrammaticality when different features are violated, or when different numbers of features are violated. Cross-linguistic studies so far in the literature have yielded support for both possibilities (Lukatela et al. 1987 for Serbo-Croatian; de Vincenzi 1999 for Italian; Barber & Carreiras 2005 for Spanish; Nevins et al. 2007 for Hindi).

Our results do not support gradient grammaticality and suggest that grammaticality is categorical, at least in the domain of morphology. At the critical word, only the number 1 condition showed the basic grammaticality effect between the grammatical form and the completely ungrammatical form (both case and number features are incorrect). In this context, there is no difference between the violation of a single feature (case or number), and the violation of both features. There is also no difference depending on whether a case feature, or a number feature is violated.

At the spill-over region, both the number 1, and the 5+ number context showed the basic grammaticality effect. In the number 1 context, the number of features that were violated has no effect on the reading time. In the 5+ number context, however, there was a slight difference in the
features. Although all three ungrammatical forms are read significantly longer than the grammatical form, the condition that has the incorrect case feature, but a correct number feature (Nom.Pl.), was read marginally faster than the two-feature violation condition (469 vs. 513ms, p=.06). Whether this marginal effect indicates gradient grammaticality is not clear. Note that this is a delayed effect at the spill-over region, and that furthermore, this effect only appeared in the 5+ number context. It is possible that this effect is specific to the processing of the Nom.Pl. form in that particular context, which may be due to frequency or morphological markedness (compared to Gen.Pl.). It is also possible that the lack of gradience is due to the synthetic nature of Russian inflection: it is hard to separate the features in a single morpheme, and fast online processing in such contexts may facilitate categorical decisions. If this explanation is on the right track, we can predict a more likely gradient effect in those languages that have agglutinative morphology. Of course, in order to test this last notion, more cross-linguistic research on morphological processing is needed.

5. Conclusions

This paper presented two experiments designed to understand the structure of Russian numerical expressions, and in particular, the underlying representation of the noun forms occurring with the numerals 2-4 (paucals). To avoid additional complexities arising in the numerical paradigm, the experiments involved numerical expressions in the nominative only, and the nouns used were all masculine (to minimize case syncretism).

The results on the processing of Russian case/number marking suggest that Gen.Sg. in paucal contexts is actually different from the Gen.Sg. proper observed in other (non-numerical) contexts. We further suggest that its underlying representation is non-singlular. We arrived at this conclusion by comparing the grammatical number/case forms with the ungrammatical ones in
different numerical contexts, in both offline and online experiments. The status of the numerical Gen.Sg. in the paucal context has long been a challenging issue in Russian linguistics, so these results add to the growing body of literature that makes use of online processing methodologies to address theoretical linguistic issues.

We also hypothesize, albeit with less conviction, that the case of the noun in the paucal context may be nominative—on par with the nominative that is used with the numeral ‘one.’ If this tentative conclusion is on the right track, Russian has a singular nominative and a paucal nominative occurring with the numerals ‘one’ and 2-4 respectively. If so, should one expect the noun co-occurring with the numeral 5 and up to be nominative plural? Neither the overt morphology nor the processing data support this idea. What then, makes the genitive plural the odd one out? Could it be the idea that large sets are potentially infinite and putting a number on some of their members necessarily entails partitivity? We leave this question open.

Our results suggest that from the standpoint of processing, the singular numerical context might be easier, and is therefore processed faster than the plural contexts. While we have confirmed this asymmetry for Russian, it remains to be seen if the singular preference is universal, possible rooted in cognition, or if it is language-specific. In addition, the assessment of grammaticality in Russian numerical contexts by native speakers seems to be categorical, rather than gradient. This may be due to the limited number of contexts we considered in this study, or to the inflectional (fusional) character of Russian morphology, where separate features are bundled in one exponent. Further work, especially on the processing of agglutinative languages, is needed to clarify this.

The ability to generalize from linguistic segments to abstract mental representations is a fundamental property of human language. The processing data presented in this paper provide new support to the idea that linguistic representations can be abstracted away from surface
linguistic forms, and that a surface form and its underlying representation could potentially be very different. In real-time processing, speakers are very sensitive to any mismatch between the underlying representation and the surface form.

Notes


2 We will not be concerned with approximative constructions where the numeral follows the noun, e.g., štuk sem’ ‘around/about seven items’ (cf. Billings 1995, Mel’čuk 1985, Pereltsvaig 2006, Suprun 1959).

3 Deadjectival nouns (e.g., životnoe ‘animal,’ buločnaja ‘bakery’) always appear in the genitive plural with the numerals 2 and above, and we will not include or discuss these nouns here.

4 For a comprehensive discussion of paucal numerals and origins of paucal systems, see Corbett (2000).

5 We would like to emphasize that we are using “markedness” in a very narrow, specific sense, as defined by the number of possible exponents, and the availability of a null exponent.

6 There is no difference between the case violation, and the number violation conditions.

References


