A phonetically natural vs. native language pattern: An experimental study of velar palatalization in Serbian

Abstract. This paper reports on a set of experiments designed to test the naturalness hypothesis of velar palatalization in different morpho-syntactic contexts. The hypothesis is based on typological surveys of various languages with velar palatalization (Bhat 1978, Guion 1994, 1998, Bateman 2011) which reveal the same pattern: if a language has palatalization before [e], then it has palatalization before [i], but not necessarily vice versa. Serbian seems to be a counterexample to this typological generalization in certain morpho-syntactic contexts, one of which is the present tense verbal paradigm, the context examined in this paper. In this particular context, Serbian palatalizes a velar stop [k] to a palatoalveolar affricate [ʧ] before the mid front vowel [e] but fails to do so before the high front vowel [i]. Two computer-based experiments were conducted to test whether Serbian speaking children and adults generalized from the existing pattern of palatalization before the mid vowel [e] to the natural pattern of palatalization before both mid and high vowels in this particular context. The first experiment was set in a native language context and the second one was an artificial pattern learning experiment. The results from the first experiment show that children largely conform to the phonetically natural pattern while adults do not. These results suggest that native speakers must be exposed to the pattern that ‘violates’ the phonetically natural one for a substantial period of time (reaching their adulthood language proficiency) in order to overwrite the phonetically natural pattern. The results from the second experiment show that the type of the task together with the type of palatalization (before [i] or [e]) play a crucial role, while age does not. These findings strengthen the hypothesis (Wilson 2006, Moreton 2008, Hayes et al. 2009) that subjects are more likely to choose a phonetically natural form presented to them than to volunteer it.

1. Introduction

This paper reports on an experiment designed to test the naturalness of velar palatalization in different contexts. Typological surveys of various languages with velar palatalization (Bhat 1978, Guion 1994, 1998, Bateman 2011) reveal the same pattern: if a language has palatalization before [e], then it has palatalization before [i], but not necessarily vice versa. Although Serbian generally adheres to this principle, which I will call (following Wilson 2006) the naturalness hypothesis, it does however present a counterexample to this typological generalization in certain morpho-syntactic contexts: the present tense verbal paradigm, in particular. Serbian has what will be referred to as a native language pattern of velar palatalization in present tense: a velar stop [k] palatalizes to a palatoalveolar affricate [ʧ] before the mid front vowel [e] but not before the high front vowel [i]. Because this paper focuses on speakers of a language that violates the generalization that the palatalization of velars before mid vowels implies palatalization before high vowels only in a specific morpho-syntactic context, the results of the experiments discussed cannot be taken to predict the behavior of speakers whose languages violate the naturalness hypothesis across the board (to my knowledge, no such languages are reported). However, the results do raise interesting questions with respect to mental grammars and how they are ‘adjusted’ after the exposure to patterns that violate the naturalness of language phenomena. At the same time, the results

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2 Two other velars ([g] and [h]) also undergo palatalization in the same context but they are not further discussed in the paper. This was done to avoid additional complexity of the experiments; for instance, the differences in frequency of the verb stems that have the final [k], [g] or [h], and the number of experimental items, which would be triple the size if it were to include all three velars and consequently, probably overwhelming for the participants.
suggest that the phonetically natural pattern is still present in the grammars of Serbian native speakers who use (and sometimes favor) this pattern if asked to generalize outside their native language data.

Generally speaking, the change of velars to palatoalveolars before front vowels and the palatal glide is commonly called the First Slavic Palatalization (Mrazović and Vukadinović 1990; Schenker 1993; Guion 1994). There is, however, another type of velar palatalization: the Second Slavic Palatalization (ibid.). This sound change affects velars in that they change to dental affricates before front vowels ([k] becomes [ʦ], for instance). The two Slavic palatalizations are two separate phenomena. They differ not only in the outcomes of the change that the velars undergo ([f] vs. [ʦ]) but also in the front vowels that trigger the change. The front vowels involved in the Second Slavic palatalization are the result of monophthongization (they came from the Proto-Slavic diphthongs [ai] and [oi]) whereas this is not the case with the front vowels triggering the First Slavic palatalization. Also, the two Slavic palatalizations appeared at different times throughout the language development (their names reflect the chronological order of their appearance). This paper focuses on one instance of the First Slavic Palatalization type: palatalization of the voiceless velar stop [k] to the palatoalveolar affricate [ʧ] before mid and high front vowels [e] and [i] in the present tense verbal paradigm in Serbian.

Two computer-based experiments were conducted to test whether Serbian speaking children and adults would generalize from the existing native language pattern (palatalization before mid vowels) to the presumed phonetically natural pattern (palatalization before both mid and high vowels). One of the experiments was set in the native language context and tested whether the native language pattern of palatalization before [e] but not before [i] applies only to existing verbs in Serbian or whether the process is extended to new verbs as well — that is, whether velars in new verbs are palatalized before high front vowels, in addition to mid front vowels. Thus, this experiment was designed to determine if the native language pattern is a productive pattern, i.e. if it applies to new forms in particular morphological configurations, and if it does, whether it is ‘stronger’ than the phonetically natural one. The second experiment was an artificial pattern learning experiment in which participants first learned a new pattern of velar palatalization and then were asked to generalize from the impoverished input to new contexts. This experiment tested whether Serbian speakers, who have what seems to be the marked pattern in a specific morpho-syntactic context in their native language, favor the phonetically natural pattern when asked to generalize from a newly learned pattern to new contexts.

The results from the first experiment show that children largely conform to the phonetically natural pattern while adults do not. The results from the second experiment show that the type of the task together with the type of palatalization (before [i] or [e]) play a crucial role, while age does not.

The naturalness hypothesis is questioned from two points of view: how universal the hypothesis is, given the fact that it does not hold true in Serbian present tense verbal paradigm; and what pattern emerges in new contexts, the native language pattern or the cross-linguistically natural pattern.

2. Background on velar palatalization

Palatalization is a very common synchronic alternation across languages. This paper focuses on the palatalization of the voiceless velar stop [k] to the palatoalveolar affricate [ʧ] when it precedes the mid and high front vowels [e] and [i]. Voiceless velar palatalization before front vowels is considered to be the most common type of palatalization (Bloomfield 1933:378, Chen 1973, Bhat 1978, Hock 1991, Guion 1998) and it is found throughout the Slavic languages (Comrie and Corbett 2003), some dialects of Italian (Calabrese 1993), Kinyarwanda (Ladefoged & Maddieson 1996) and French (Buckley 2003), to mention but a few. This common pattern of palatalization before front vowels appears to be phonetically motivated. Velars followed by front vowels have articulatory, acoustic and perceptual similarities with palatoalveolar affricates. An X-ray study by Keating and Lahiri (1993) shows that velar stops in Czech, Hungarian, English and Russian are articulated further front on the palate when followed by front vowels than when followed by back vowels and this fronting effect makes the articulation of velar stops and

3 For a detailed description of the two palatalizations, see Schenker (1993) and Guion (1994) and references therein.
palatoalveolar affricates somewhat similar. The acoustic similarity of fronted velars and palatoalveolar affricates is observed in the peak spectral frequency (Guion 1998).

Typological studies of various languages with velar palatalization have shown that if a language has palatalization before the mid front vowel [e], it is expected to also have palatalization before the high front vowel [i], but not necessarily vice versa (originally observed by Ohala 1992). This observation led to postulation of the naturalness hypothesis (Wilson 2006:950), presented in (1) below:

\[
\begin{align*}
(1) & \quad a. \ (/ki/ \rightarrow /ʧi/) < (/ke/ \rightarrow /ʧe/) \\
& \quad b. \ (/ki/ \rightarrow /ʧi/) > (/ke/ \rightarrow /ʧe/) 
\end{align*}
\]

To test the hypothesis that mid front vowel [e] palatalization is most likely to generalize to high front vowel [i] palatalization, Wilson (2006) designed an artificial pattern learning experiment involving two groups of participants, all native speakers of American English. One group was exposed exclusively to a pattern of velar palatalization before the high front vowel [i] and the other group to the pattern of palatalization before the mid front vowel [e]. After the exposure phase, the participants were tested to determine whether they would generalize the palatalization to other vowel contexts, the front vowel that they were not exposed to and the back vowel [a]. The results show that the participants generalized palatalization from the mid front vowel to the high front vowel much more often than they generalized palatalization before the high front vowel to the mid front vowel. The results of Wilson’s experiment supported the naturalness hypothesis not only for speakers who have productive velar palatalization in their phonological systems but also for those who do not. The acoustic, articulatory and perceptual similarities between velars followed by front vowels and palatoalveolar affricates are shown to be phonetically natural.

The question that this paper addresses is: will Serbian speakers show evidence of knowledge of the phonetically natural pattern when lexical information does not bias them towards the native language pattern? This will be tested with two conditions: (1) new verbs in their native language and (2) new forms in an artificially learned pattern. Before we turn to the experiments, let us first take a closer look at the existing pattern of velar palatalization in Serbian.

3. Velar palatalization in Serbian

Velar palatalization is a productive morphophonemic alternation in Serbian. It appears in different morphological contexts and its triggering elements vary. The focus of the paper is on the palatalization of [k] before mid and high front vowels [e] and [i]. In the present tense verbal paradigm, there is palatalization before [e] but not before [i]. Since palatalization before [i] does not appear in this paradigm, although the naturalness hypothesis would seem to predict it should, the paradigm presents an interesting place to test the hypothesis. However, before we take a closer look at the present tense verbal paradigm, let us look at velar palatalization before [e] and [i] in Serbian in general.

Voiceless velar palatalization appears before the high front vowel [i] only in derivational morphology. The following are derivational processes of this kind.

(2) Voiceless velar palatalization before [i]

a. derivation of a noun from an adjective (by suffix /-ina/):

\[
\begin{array}{ccc}
\text{strong.ADJ} & + & /-ina/ & \rightarrow & \text{strength.NOUN} \\
\end{array}
\]

b. derivation of a verb from a noun (by suffix /-iti/):

\[
\begin{array}{ccc}
\text{weak.ADJ} & + & /-iti/ & \rightarrow & \text{strength.NOUN} \\
\end{array}
\]
c. derivation of a perfective from an imperfective verb:

\[
\begin{array}{c|c|c}
\text{skakati} (jump.IMPERF.VERB) & \rightarrow & \text{skoʧiti} (jump.PERF.VERB) \\
\end{array}
\]

d. augmentatives (by suffix /-ina/):

\[
\begin{array}{c|c|c}
\text{ʧovek} (man) & + & /-ina/ \\
\downarrow & & \rightarrow \\
\text{ʧoveʧina} (man.AUG) & \\
\end{array}
\]

e. diminutives (by suffixes /-its/ and /-itsa/):

\[
\begin{array}{c|c|c}
\text{defjаk} (boy) & + & /-its/ \\
\downarrow & & \rightarrow \\
\text{defjаfits} (boy.DIM) & \\
\hline
\text{slika} (picture) & + & /-itsa/ \\
\downarrow & & \rightarrow \\
\text{sliʧitsa} (picture.DIM) & \\
\end{array}
\]

Voiceless velar palatalization before the mid front vowel [e] can be found in both inflectional and derivational morphology.

(3) Voiceless velar palatalization before [e]

a. masculine singular vocative inflection (by suffix /-е/):

\[
\begin{array}{c|c|c}
\text{vojnik} (soldier.NOM) & + & /-е/ \\
\downarrow & & \rightarrow \\
\text{vojniʧе} (soldier.VOC) & \\
\end{array}
\]

b. derivation of adverbial comparatives (by suffix /-е/):

\[
\begin{array}{c|c|c}
\text{jako} (strong.POSITIVE) & + & /-е/ \\
\downarrow & & \rightarrow \\
\text{jaʧе} (strong.COMPARATIVE) & \\
\end{array}
\]

c. derivation of passive participle (by suffix /-ен/):\(^4\)

\[
\begin{array}{c|c|c}
\text{pek-} (bake.STEM) & + & /-ен/ \\
\downarrow & & \rightarrow \\
\text{peʧen} (baked) & \\
\end{array}
\]

d. diminutives (by suffix /-е/):

\[
\begin{array}{c|c|c}
\text{jastuk} (pillow) & + & /-е/ \\
\downarrow & & \rightarrow \\
\text{jastuʤе} (pillow.DIM) & \\
\end{array}
\]

\(^4\) Historically in the derivation of passive participles palatalization occurred as a result of the coalescence of the velar and the morpheme-initial glide [j]. However what we see now is palatalization before the mid front vowel [e]. A similar situation is encountered with comparatives, where historically palatalization occurred as a result of the coalescence of the velar and the glide. Synchronically, palatalization looks like it occurs before vowels: both back and front vowels, which are gender and number suffix initial, e.g. /jak- (strong) → /jaʧ- (stronger) feminine, singular; /jaʧ-м masculine, singular; /jaʧ-е feminine, plural.
Let us now look at cases when palatalization does not take place in the same phonological environment. Palatalization before the high front vowel [i] does not appear in the following instances of derivational morphology:

(4) Failure of voiceless velar palatalization before [i]

a. derivation of possessives (by suffix /-ina/):

/baka/ + /-ina/ → /bakina/
grandma SUFFIX grandma.POSS

b. derived iteratives:

/vikati/ → /povikivati/
shout.IMPERF shout.ITERATIVE

c. female nationality (by suffix /-iɲa/):

/grk/ + /-iɲa/ → /grkiɲa /
Greek.MASC SUFFIX Greek.FEM

d. diminutives (by suffixes /-iʨ/ and /-iʦa/):

/sok/ + /-iʨ/ → /sokiʨ/
juice SUFFIX juice.DIM

/deka/ + /-iʦa/ → /dekiʦa/
grandpa SUFFIX grandpa.DIM

What immediately stands out from the data presented above is the fact that palatalization does not take place consistently before the suffixes beginning in a high front vowel in diminutives. The same suffixes in the same phonological environment yield different outcomes, palatalized and non-palatalized. It is also not uncommon to encounter co-existent palatalized and non-palatalized diminutive forms of the same word:

(5) /ruka/ + /-iʦa/ → /rukiʦa/
arm SUFFIX /ruʃiʦa/

Therefore, it could be concluded from the data above that [i] palatalization in Serbian is restricted to derivational morphology and is sometimes even optional (diminutives). Interestingly, borrowed words do not undergo palatalization in the context just described:

(6) /disk/ + /-iʨ/ → /diskiʨ/
disk SUFFIX disk.DIM

Voiceless velar palatalization before the mid front vowel [e] does not appear in some instances of inflectional morphology:

(7) Failure of voiceless velar palatalization before [e]
a. masculine plural accusative (by suffix /-e/):

/uʧenik/ + /-e/ → /uʧenike/
pupil.NOM.SG SUFFIX pupil.ACC.PL

b. feminine plural nominative/accusative (by suffix /-e/):

/devojka/ + /-e/ → /devojke/
girl.NOM.SG SUFFIX girl.NOM/ACC.PL

c. feminine singular genitive (by suffix /-e/):

/devojka/ + /-e/ → /devojke/
girl.NOM.SG SUFFIX girl.GEN.SG

Palatalization before the mid front vowel [e], when compared to palatalization before [i], is more widespread in the sense that it appears in both derivational and inflectional morphology. Furthermore, palatalization of [k] before [e] invariably occurs in derivational morphology. There are no instances of non-palatalized forms or co-existent non-palatalized forms (such as those we saw for [i] palatalization in the derivation of diminutives). But the differences between the palatalization before [e] and before [i] are particularly notable in the present tense verbal paradigm. There are three conjugation classes, indicated by present tense theme vowels [i], [e] or [a] followed by person and number suffixes:

(8) a. /ʧek-/ + /-am/ → /ʧekam/
wait.VERB STEM + SUFFIX.PRESENT TENSE.1SG ‘I wait’

b. /plak-/ + /-em/ → /plʤem/
cry.VERB STEM + SUFFIX.PRESENT TENSE.1SG ‘I cry’

c. /zrik-/ + /-im/ → /zriʤim/
squint.VERB STEM + SUFFIX.PRESENT TENSE.1SG ‘I squint’

As the examples above illustrate, it is only the stem final velar [k] verbs that take the initial mid high front vowel [e] inflectional suffix that palatalization targets ([k] palatalizes to a palatoalveolar affricate [ʧ], as shown in 8b). Historically, in this class of verbs palatalization occurred as a result of coalescence of the velar and the inflectional morpheme-initial glide [j]. Synchronically, palatalization appears to occur before the vowel [e]. What is interesting for the purposes of the study reported in this paper is that native speakers do not have knowledge about the historical development but rather rely on the pattern that they see in the language at present, i.e. palatalization takes place before the initial mid front vowel [e] inflectional suffix and the third person plural is a case of paradigm leveling.5

Verbs taking the present tense theme vowel [a] suffixes are the greatest in number. Verbs taking the [e] suffixes constitute a smaller set and the ones taking the [i] suffixes even smaller. In fact, the latter are restricted to ‘baby-talk’ verbs (Comrie and Corbett 2003). Put differently, there is a frequency difference among the verb classes that are to be tested in the study.

It is important to note here that the theme vowels [i], [e] and [a] are initial vowels of the inflectional suffixes, added to the verb stems to mark present tense. There are however derivational

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5 The third person plural was not tested in the study reported here but it presents a candidate for a future study. It would be interesting to see whether [ku] – [ʧu] alternation extends to new verbs in Serbian since the alternation is highly morphologized and not phonetically driven.
suffixes with the initial [i] and [e] vowels, which could trigger velar palatalization (as shown in 2b for instance, where a verb is derived from a noun by adding the initial high front vowel [i] suffix). So in these cases, the root of the verb already contains a palatoalveolar affricate, as a result of palatalization triggered by the vowel initial derivational suffix. As such, these verbs do not present candidates to test the triggers of palatalization with inflectional suffixes and are not further discussed. The focus of the study is on verbs with stem final voiceless velar [k] and the interaction (palatalization or not) between the velar and the initial vowel of the inflectional suffix marking present tense [i], [e] or [a].

The table below shows conjugation of two verbs taking the [e] initial suffix and one verb taking the [i] initial suffix. The two verbs taking [e] initial suffix have a different infinitive form and they belong to two different verb stem classes. In both of them the voiceless velar [k] undergoes palatalization. The important difference between the two for the purposes of this study is that the verb having /-tsi/ infinitive suffix does not have the voiceless velar in its infinitive form, e.g. /petɕi/, whereas the /-ti/ infinitive verb does, e.g. /skakati/. It is assumed that Serbian speakers have to know a stem form of the /-tsi/ verbs where the voiceless velar surfaces, e.g. /pek-/ in order to be able to use the verb in the present tense. This is important for the design of the first experiment because the verbs are introduced in their infinitive form and then used in the present tense; and in order for participants to know that there is a voiceless velar, the /-ti/ infinitive verbs are used.

<table>
<thead>
<tr>
<th></th>
<th>/petɕi/ ‘to bake’</th>
<th>/skakati/ ‘to jump’</th>
<th>/sikiti/ ‘to suckle’</th>
</tr>
</thead>
<tbody>
<tr>
<td>SG</td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>peʃem</td>
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<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>peʃe</td>
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<td>PL</td>
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</tr>
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<td></td>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>peku</td>
<td>skaʃu</td>
</tr>
</tbody>
</table>

4. Experiment 1: Testing the native language pattern in new words

This experiment tested whether Serbian native speaker children and adults would generalize from the existing pattern of palatalization before mid front vowels to the natural pattern of palatalization before both mid and high front vowels when the speakers learn new words in their native language. Because the native language pattern is so common in the present tense verbal paradigm of many verbs, this paradigm was used in the experiment. As already mentioned, there are three conjugation classes, indicated by present tense theme vowels [i], [e] or [a] followed by person and number suffixes (illustrated in the example (8) above). The suffixes provide a full set of potentially palatalization-triggering elements, which includes both front vowels as well as a back vowel environment. Further, and more important for the purposes of this study, palatalization appears before the mid front vowel [e] but not before the high front vowel [i], contrary to the predictions of the naturalness hypothesis. This distribution of palatalization raises important questions: 1) is the native language pattern a learned pattern that ‘overwrites’ the phonetically natural one; 2) is it a productive pattern, i.e. does its application extend to new verbs; these questions are addressed in the first experiment.

The verbs were introduced in the infinitive form and participants were asked to choose from three possible present tense forms of the verb the one that they considered to be ‘correct’. At the beginning of the experiment, the participants were explicitly told that they would learn new verbs in their native language. The idea behind this was to make sure that the participants knew the experiment was about their native language. We tested which phonological patterns would apply to new words: the pattern present in

<sup>6</sup> There is no palatalization before the mid front vowel [e], which is the opposite of what we have witnessed with the verbs taking [e] initial suffix so far (where palatalization invariably applies). This is an example of paradigm leveling.
their native language or the phonetically natural pattern, which learners should be predisposed to (Wilson 2006).

4.1. Stimuli

The stimuli were possible but nonexistent verbs of the form $C_1VC_2$ followed by the existing Serbian infinitive suffix [-ati], as in [hakati]. The first consonant ($C_1$) came from the existing set of Serbian consonants [$b$ $v$ $g$ $d$ $cz$ $z$ $j$ $k$ $l$ $\lambda$ $m$ $n$ $p$ $r$ $s$ $t$ $ts$ $f$ $h$ $\tilde{f}$ $\tilde{d}$ $\tilde{j}$]. The vowel (V) was drawn from the existing set of Serbian vowels [$a$ $e$ $i$ $o$ $u$]. The second consonant ($C_2$) came from the set [$b$ $d$ $k$ $l$ $m$ $n$ $p$ $f$ $]$. This set of consonants was used because the consonons in the set, except [k], rarely undergo any sound change in the present tense verbal paradigm in Serbian. In fact, some of these consonons do undergo sound change when followed by the mid front vowel [e] initial suffix but they do not if the suffix has the initial [a] or [i] vowel. Only three of the consonants from the set above, namely [b $m$], appeared with the mid front vowel [e] initial suffix. The labials [b $m$] have two possible outcomes: (i) no change, as in /grebati/ ‘to scratch’ $\rightarrow$ /grebe/ ‘scratch.3SG’ and /razumeti/ ‘to understand’ $\rightarrow$ /razume/ ‘understand.3SG’ and (ii) change, as in /zobati/ ‘to peck’ $\rightarrow$ /zob$\tilde{a}$e/ ‘peck.3SG’ and /hramati/ ‘to limp’ $\rightarrow$ /hram$\tilde{e}$/ ‘limp.3SG’. The experiment was set up in such a way that the participants were forced to choose one of the provided forms and these forms did not contain tokens that underwent [b] $\rightarrow$ [b$\tilde{a}$] or [m] $\rightarrow$ [m$\tilde{a}$]. This was done in order to avoid introduction of additional sound changes and to focus on testing only velar palatalization. The nasal palatal [p] does not undergo any change. The critical items were the ones where $C_2$ was [k], such as [sukati]. The items where $C_2$ was drawn from the rest of the set, that is [b d l m n p f ], were fillers, as in [dipati].

Nonexistent verbs were introduced in the infinitive form. The participants were presented with pictures of boys or girls performing some actions. Each of the pictures introduced a new verb. Once presented with a new verb, the participants were asked to choose one from three provided present tense forms by providing a verbal response to the experimenter. The choice for the critical items always included (i) a palatalized form, where the velar [k] followed by the mid or high front vowel was palatalized, as in [haf$\tilde{e}$] for the infinitive [hakati]; (ii) a non-palatalized form, where the velar [k] followed by the mid or high front vowel was not changed, as in [hake]; and (iii) a control case, where the velar [k] underwent an unattested change, as in [hake]. The first two forms – palatalized and non-palatalized – were critical for the experiment. The third one – the random consonant change – was used to test the possibility that the participants simply wanted to choose the form that is ‘randomly’ different from the given one. These sound changes were completely random.

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7 As pointed out by an anonymous reviewer, this set could have contained the [d] voiceless counterpart, i.e. [t]. The same reviewer also wondered why nasal [n] was not included in this set. It was not included in the set because the majority of verb stems with the final [n] take /-uti/ infinitive suffix, as in /gurnuti/ ‘to push’ and not /-ati/.

8 The pictures were taken from the website www.clipart.com.

9 An anonymous reviewer pointed out that giving an option of only three possible answers might skew the results. The choice of three possible answers was driven by the fact that we wanted to test if the palatalization would take place: palatalized vs. non-palatalized form. The third answer was introduced to control for random choice, signaling that the participant is not following any phonological pattern. If instances of other sound changes were given as a possible answer, like the Second Slavic palatalization (as suggested by the reviewer), we would be testing a pattern that does not exist in the language; i.e. the Second Slavic palatalization does not take place in the present tense verbal paradigm. It is true that the participants might have been making completely different generalizations (if given attested alternations in the wrong environment) and these cases present themselves as candidates for a follow-up study.

10 In this particular example, [hakati], the use of the mid high front vowel [e] in the suffix was forced. The three suffix initial vowels: high front vowel [i], mid front vowel [e] and back vowel [a], are evenly distributed among the stimuli.
The fillers, such as [dipati], always included three forms: (i) no change, where \( C_2 \) was not changed, as in [dipe]; (ii) changed form, where \( C_2 \) underwent a possible sound change but not one specifically found in this environment in Serbian (such as voicing), as in [dibc]; and (iii) random change, where \( C_2 \) underwent an unattested consonant change, as in [dihe]. The fillers controlled for random phonological changes and a systematic application of velar palatalization only. In other words, they were indicators of whether (1) the participants simply wanted to choose the form that was different from the initial one, following no phonological rule (a random phonological change); (2) they applied some phonological change (velar palatalization or any other existent phonological change); or (3) they systematically applied the phonological pattern of velar palatalization and thus did not change the fillers since they were not subject to velar palatalization.

The experiment consisted of 40 nonce verbs, all of which were introduced in the infinitive and tested in the third person singular form. There were 30 verbs in which \( C_2 \) was \([k]\) and 10 in which \( C_2 \) was taken from the filler set \([b\,d\,l\,m\,n\,p\,f]\). Of the 30 verbs, 10 had the \([a]\) initial suffix, another 10 the \([e]\) initial suffix and, another 10 the \([i]\) initial suffix. Of 10 fillers, 3 had the \([a]\) initial suffix, 4 the \([e]\) initial suffix and 3 the \([i]\) initial suffix. The critical items and fillers were randomized so that the participants could not ‘discover’ the pattern. The three types of choices appeared in random order for the same reason.

The two suffix environments \([i]\) and \([e]\) were critical since Serbian does not palatalize before the high front \([i]\) initial present tense inflectional suffix whereas we find palatalized alternations before the mid front \([e]\) initial present tense suffix. Such a pattern contradicts the naturalness hypothesis. The back vowel \([a]\) was included in the experiment as a control case since this vowel does not trigger velar palatalization in Serbian present tense verbal paradigm.

The alphabet used in the experiment was Cyrillic. This was done because the experiment involved reading of the stimuli and it included children between 7 and 9 years of age. At this age, the children master the first alphabet, Cyrillic, at school. This was done to avoid potential mistakes in presenting the stimuli, especially among children, since they were reading the stimuli themselves. The orthographic system of Serbian is phonetic.

4.2. Participants

Fifteen children and fifteen adult L1 speakers of Serbian participated in this experiment. There were eight female and seven male children and eleven female and four male adults. All of the participants are residents of the same town, Novi Sad. The age of the children ranged from 7 to 9 and the adults from 25 to 69. The participants were not paid. The experiment was anonymous; the only personal piece of information that was obtained from the participants was their gender and date of birth.

4.3. Procedure

During the experiment participants were seated in front of a laptop computer and stimuli were presented to them on the computer screen, using Microsoft PowerPoint 2007. There was no time limit for the experiment; the participants moved to the next slide whenever they felt they were ready to do so. At the beginning of the experiment, they were given instructions. The first few slides of the presentation stated that they were about to learn some new verbs in their native language. In order to make sure that the participants fully understood the task, they were given the example in the instruction section in which the existing Serbian verb was used.\(^{15}\) The existing verb used in the example does not undergo velar palatalization in Serbian present tense verbal paradigm (\([i]\) initial suffix). Unattested sound changes are changes that are not attested in any language.

\(^{11}\) Possible sound changes are the ones that exist in phonological systems of some languages such as voicing (existent in German for instance). Unattested sound changes are changes that are not attested in any language.

\(^{12}\) The participants were given only one example of the existing verb in Serbian. The example illustrated that the verb given in the infinitive form needs to be put in the present tense form. No other examples were given since the task the participants were asked to perform involved applying the pattern existent in their native language and it was assumed that no further practice items were needed.
palatalization in the present tense verbal paradigm. This way the participants were not biased to use velar palatalization. The participants were further told that the new verbs were going to be presented to them in the following way: first, a picture of a boy or a girl performing an action would be presented to them. Beneath the picture, a new verb would be written in capital letters. The verb was used in a simple sentence that stated what the boy or the girl would be doing the next day. For instance:

(9)

Дечак he сутра ХАКАТИ.
[деʧак tɛ sutra hakati]
boy AUX tomorrow HAKATI
‘The boy will HAKATI tomorrow.’

The future tense was used because it forces a lexical verb to appear in the infinitive form. The same form of a sentence was used for all the stimuli. As mentioned earlier, after the participants were introduced to a new verb, they were asked to choose one of the three provided forms of the verb in the present tense. In the instruction section, it was explicitly said that only one verb form could be chosen.

The present tense form was forced by a when clause, in which a lexical verb obligatorily appears in present tense. The sentence that was used in all of the stimuli stated that a girl or a boy was happy when she or he performed an action described by a newly introduced verb. For instance:

(10) Дечак je срећан кад а. ХАКЕ 6 ХАЧЕ b. ХАЉЕ
[деʧак je sreʨan kad] [hake] [hɑʧe] [hɑɭe]
boy AUX happy when ‘The boy is happy when he ...’

When the participants decided which form they found ‘correct’, they spoke the chosen form to the experimenter, who wrote down their choice. This was done in order to facilitate automatic responses for both age groups (children and adults). After the participants uttered the chosen verb form, they clicked on the space button on the laptop and moved to the next slide, which presented them with a new verb.

4.4. Results

The results reveal differences between the two age groups. The adults unanimously chose forms with palatalization before the mid vowel (100%) but much less frequently before the high vowel (22%). They very infrequently palatalized before the back vowel (0.7%). The fillers were rarely changed, only 3.4%. The table below summarizes these results.

Table 1
Experiment 1. Results for adults

---

13 The example including [i] initial suffix would be: [nokati] → [noki], [nɔʧi], [nɔbi].
14 The percentage refers to number of response tokens of total in group.
The adults never applied a random sound change to the velar [k]. Further, as Table 1 shows, the fillers were generally not changed. It might be interesting to notice, though, that the change in fillers was more likely to appear before the mid front vowel (4 out of 5 items) than the low back vowel (1 out of 5 items).

The children, on the other hand, largely chose forms with palatalization before both mid (98%) and high front vowels (90%). As opposed to the adults, the children did apply a random sound change to both critical items and fillers. The critical items underwent these changes infrequently: for the high front vowel following the velar [k] there were only 0.7% such responses; 2% for the mid front and 9.3% for the back vowel. These percentages are small and as such do not affect the overall tendency observed. The children failed to palatalize the velar before the high front vowel [i] only 9.3% of the time. Further, they infrequently palatalized before the back vowel [a], 8% of the time. Such results show that velar palatalization was systematically applied and there was a strong tendency towards the phonetically natural pattern.

As for the fillers, a random sound change did occur in the majority of responses, 53.4%; whereas no change occurred 46.6% of the time. The forms that were changed occurred 46.25% of the time before the mid front vowel [e], 28.75% before the high front vowel [i] and 25% before the back vowel [a]. This result was not predicted but it is relevant to observe that even a random sound change largely occurred before the mid front vowel [e]. The results are summarized in Table 2 below.

Table 2
Experiment 1. Results for children

<table>
<thead>
<tr>
<th></th>
<th>[ki] (10)</th>
<th>[ke] (10)</th>
<th>[ka] (10)</th>
<th>filler (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>palatalized</td>
<td>22%</td>
<td>100%</td>
<td>0.7%</td>
<td>0%</td>
</tr>
<tr>
<td>non-palatalized</td>
<td>78%</td>
<td>0%</td>
<td>99.3%</td>
<td>96.6%</td>
</tr>
<tr>
<td>other</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>3.4%</td>
</tr>
</tbody>
</table>

For the cases where participants from both age groups palatalized the velar stop [k], we conducted a by-subject ANOVA with the vowel ([i], [e], [a]) as a within-subject factor and with age (adults vs. children) as a between-subject factor. We found two main significant effects. There was a significant age effect (F(1,29)=70.349, p<.0001), which suggests that the children and the adults differ significantly in their responses. The interaction among the vowels also shows a significant effect (F(2,28)=521.316, p<.0001). The high front vowel [i] responses significantly differ from both mid front [e] and back vowel [a]; the mid front [e] responses significantly differ from both high front and back; and the back vowel [a] responses significantly differ from the high and mid front vowel responses. The differences are found in both age groups. These facts are summarized in Figure 1 below.

Figure 1. Comparison of responses obtained from adults and children in Experiment 1 for critical items

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15 The number in the brackets is the number of items.
16 We will use the terms ‘palatalized’ and ‘non-palatalized’ for both critical items and fillers in order to be consistent. However, it is important to highlight that the terms do not mean the same thing. Since fillers did not contain [k], they were not able to undergo palatalization at all. Thus, ‘palatalized’ for fillers means ‘changed’ and ‘non-palatalized’ means ‘not changed’. For instance, a filler [kipa] had three possible outcomes: (i) changed [kiba] (possible sound change – voicing), (ii) not-changed [kipa] and (iii) other [kitSa] (impossible sound change).
Figure 1 shows the interaction of age and vowel contexts. The gray solid line represents responses of the adult group and the black dotted line represents responses of the children to the critical items. The x-axis shows three different vowel contexts: [i], [e] and [a] whereas the y-axis presents percentages of palatalized responses (1-100%). We can see that the two age groups do not differ in the mid front vowel context [e] where both groups palatalized in front of [e] (almost 100% of palatalized responses shown on y-axis). Similarly, both groups do not differ in the back vowel context [a] where both groups did not palatalize in front of the back vowel [a]. The crucial difference is shown in the high front vowel context [i] where the children (black dotted line) largely palatalized the velar (above 80%) and the adults (solid gray line) did not (around 20%).

For the cases where participants from both age groups chose a non-existent (random) consonant change for the critical items, we conducted a by-subject ANOVA with the vowel ([i], [e], [a]) as a within-subject factor and with age (adults vs. children) as a between-subject factor. No significant effect was found, which suggests that the children and the adults show no significant difference in choosing the non-existent consonant change form. The age (F(1,29)=2.554, p=.121) and the vowel (F(2,28)=1.581, p=.224) effect for both age groups are found to be insignificant.

The results from this experiment clearly show that there is a difference between the two age groups, i.e. age plays a crucial role in applying the native language pattern in the present tense verbal paradigm in Serbian. The adults favor the native language pattern (invariant palatalization before [e] and infrequent before [i]) while the children favor the phonetically natural pattern (palatalization largely applied before both [e] and [i]). This finding is not surprising given the difference in the amount of exposure to the native language pattern between the two age groups. Interestingly, neither children nor adults chose the non-palatalized form of the velar before the mid front vowel, [ke]. This finding suggests that palatalization before the mid front vowel is strong in their native language and never fails to apply to new words.

To sum up, the experiment showed that the adults failed to generalize the phonetically natural pattern whereas the children did generalize it, despite their native language pattern.

5. Experiment 2: Testing the native language pattern in a language game

The second experiment was an artificial pattern learning experiment. It was designed to test whether the naturalness hypothesis holds for L1 speaking children and adults of Serbian in a newly learned pattern, i.e. whether the speakers would generalize to other vowel contexts from the impoverished input. The question was whether L1 speaking children and adults of Serbian would conform to the phonetically

17 The experiment reports on two different age groups (children and adults), and this represents, as one referee points out, differences in length of exposure to native patterns of palatalization.
natural pattern and generalize from the existing native language pattern of palatalization before mid front vowels to the phonetically natural pattern of palatalization before both mid and high front vowels, or they would conform to the native pattern of palatalization only before mid front vowels.

It is important to note that all experiments reported in this paper dealt with verbal morphology. The first experiment was exclusively about verbal morphology of the *existing* present tense paradigm in Serbian and tested the pattern on the nonce verbs with the real Serbian suffixes. The second experiment, on the other hand, dealt with verbal morphology of a *non-existent* paradigm in Serbian and it tested palatalization patterns on nonce verbs with nonce suffixes.

The second experiment consisted of three parts: exposure, break and test phase. In the exposure phase the participants were presented with written pairs of nonce verbs, introduced by pictures of boys and girls performing different actions (either one or three boy(s) / girl(s)). The verb in the first picture indicated an action performed by only one actor (singular) and the verb in the second picture indicated the same action performed by three actors (plural). The plural form was formed by adding one of the suffixes, [ita], [eta] or [ata]. This morphological rule of adding the plural suffixes was not revealed to the participants. Further, the suffix-initial vowel [i], [e] or [a] mapped to the gender of the people performing an action. The high front vowel [i] was used for female, the mid front [e] for male and the back [a] for mix of both male and female. Again, the participants were not told about the mapping of the suffix initial vowel to the gender of the actors. The morphological process of suffixation triggering palatalization was chosen in order to be similar to the existing process in the participants’ native language: in Serbian palatalization appears when present tense suffix [e] is added to a verb stem. However, in this experiment, the suffix did not denote tense but number and gender agreement. A morphological process of this particular kind does not exist in Serbian. It is for this reason that this morphological process was chosen for the experiment; i.e. there should not be any interference with the existing native language morphological processes. At the same time, the native language morphological process and the made-up one both include verbal lexical category and they are both inflectional.

The new words described different actions and as such could easily be understood as verbs. The purpose of this was to make participants ‘operate’ on the same morphological level. In other words, the native language pattern appears among verbs in Serbian, so the idea was that the participants might potentially rely on that pattern if they were asked to deal with the same lexical category.

There were two condition groups in the exposure phase of the second experiment: high front [i] and mid front [e]. The participants in the high front condition were presented with examples such as [jukita] … [juʧita] and the participants in the mid front condition were presented with examples such as [loketa] … [loʧeta]. Importantly, the participants in the high front condition were not presented with any examples in which the velar [k] appeared before the mid front [e]. Similarly, the participants in the mid front condition were not presented with any examples in which the velar [k] appeared before the high front [i]. All of the examples presented to each of the two condition groups, which contained the stem final velar [k], also contained the palatalized alternate.

In the test phase of the experiment, both condition groups were presented with examples in which the velar [k] appeared in three vowel contexts [a, e, i]. Therefore, in the second part of the experiment, the participants were presented with the vowel context that conditioned palatalization in the first part of the experiment ([e] for the mid front and [i] for the high front condition groups) and also with the vowel contexts that did not appear in the first part of the experiment ([i, a] for the mid front and [e, a] for the high front condition groups). The vowel context that the groups were exposed to in the first part of the experiment will be referred to as the exposure context, and the vowel contexts that appear in the second part of the experiment other than the exposure context will be referred to as the novel context. The participants were deliberately not informed whether velar palatalization should apply in the novel contexts, forcing them to rely on their own generalizations.

5.1. Stimuli
The stimuli were pairs of nonce words, where the first word was of the form C1VC2, and the second one was of the same form, C1VC2, followed by one of the three nonce suffixes: [ita], [eta] or [ata]. Both forms of the nonce words (C1VC2 and C1VC2 followed by one of the suffixes) are possible consonant – vowel combinations in Serbian; thus, they are possible ‘real’ word candidates.

The first consonant (C1) came from the set of Serbian consonants [b v g d ʒ ʒ z ʒ j ʃ k ʃ l ʃ m ʃ n ʃ p r s t ʧ ʃ ʤ ɲ]. The vowel (V) was drawn from the existing set of Serbian vowels [a e i o u]. The second consonant (C2) came from the set [b v ʒ ʒ j ʃ k ʃ l ʃ m ʃ n ʃ p r s t ʧ ʃ ʤ ɲ]. This set was randomly chosen from the existing set of Serbian consonants, excluding all the velars but [k]. The items where C2 was [k], such as [nuk], were the critical ones. The items where C2 was drawn from the rest of the set, [b v ʒ ʒ j ʃ l ʃ m ʃ n ʃ p r s t ʧ ʃ ʤ ɲ], were fillers, e.g. [saʤa].

There were two types of tasks in this experiment: gap and choice. In the gap task, the participants were asked to fill in the gap with whatever they thought was a correct response, i.e. their responses were not restricted to some set of already given answers. The participants were asked to respond in whatever way they thought they should. In the choice task, they were given three forms and they were directed to choose only one they considered to be ‘correct’. The choice for the critical items always included (i) a palatalized form, where the velar [k] followed by the mid or high front vowel was palatalized, as in [nofeta]; (ii) a non-palatalized form, where the velar [k] followed by the mid or high front vowel was not changed, as in [noketa]; and (iii) a control case, where the velar [k] underwent an unattested change, as in [nofeta]. The first two forms – palatalized and non-palatalized – were critical for the experiment, while the third one – the random consonant change – was a control. The former served to show whether the participants would apply palatalization to the velar [k] followed by different vowels in the case of suffixation or not. The latter was used to signal that the participants were not applying an attested phonological change but rather choosing a form that randomly differs from the input form.

The choice for the fillers (for instance [veleta]) always included three forms: (i) a form with no change, such as [veleta]; (ii) a changed form, where C2 underwent an existing phonological change which does not take place in Serbian (for instance, the change of [l] into [r]), as in [vereta]; and (iii) a randomly changed form, where C2 underwent an unattested consonant change, as in [vedʒeta]. The fillers controlled for random sound changes and for phonological changes that the participants were not exposed to in the first part of the experiment. They tested whether the participants just wanted to choose a form that was different from the given one not following any sound change rule or they wanted to choose a different form following some particular sound change rule (velar palatalization or any other phonological change) or they systematically applied only the phonological pattern of velar palatalization and did not change the fillers since they were not subject to velar palatalization.

The exposure phase consisted of 40 nonce words. There were 20 words in which C2 was [k] and, 20 in which C2 was taken from the filler set [b v ʒ ʒ j ʃ k ʃ l ʃ m ʃ n ʃ p r s t ʧ ʃ ʤ ɲ]. The group that was exposed to the high front vowel [i] palatalization encountered 20 words with [k] followed by the [i] initial suffix and 20 fillers followed by the [i] initial suffix. The mid front vowel [e] palatalization group was exposed to 20 words where [k] was followed by the [e] initial suffix and 20 words where fillers were followed by the [e] initial suffix. In the exposure phase both groups were presented with just one vowel context, either [i] or [e].

The test phase included 40 nonce words as well. There were 30 words with the velar [k] as C2 and 10 fillers. Out of 30 words with the velar [k] as C2, 10 had a suffix [ita], 10 [eta] and 10 [ata]. The fillers all had the same suffix that they appeared with in the exposure phase. Thus, for the [i] condition group, in the test phase, all of the fillers had the suffix [ita], and for the [e] condition group, all of the fillers had the suffix [eta]. In both exposure and test phases, the critical items and fillers were randomized. The same was done with the three choices in the choice task.

The two vowel contexts [i] and [e] were the critical factors, while the back vowel [a] was included in the experiment as a control. The naturalness hypothesis states that if there is palatalization before [e] then palatalization before [i] is asymmetrically implied. The hypothesis predicts that there should be no generalization to palatalization before the back vowel [a] from the front vowel contexts.
5.2. Participants

Fifteen children and fifteen adult L1 speakers of Serbian participated in the high front vowel condition group. There were six female and nine male children and thirteen female and two male adults. The age of the children ranged from 7 to 9 and of the adults from 21 to 64. In the mid front vowel condition group, there were fifteen children and fifteen adult L1 speakers of Serbian: seven female and eight male children and twelve female and three male adults. The age of the children ranged from 7 to 9 and of the adults from 21 to 63. All participants are the residents of the same town, Novi Sad. The participants were not paid. The experiment was anonymous; the only personal piece of information obtained from the participants were gender and the date of birth. Participants of experiment 2 were different from the participants in experiment 1.

5.3. Procedure

The experiment consisted of three parts: exposure, break and test phase. The three parts appeared in the order presented. There was no time limit for either of the phases.

The first part of the experiment was an exposure phase. In this phase, the participants were seated in front of a laptop computer and stimuli were presented to them on the computer screen, using Microsoft PowerPoint 2007. At the very beginning of the exposure phase, the participants were given instructions. It was explicitly stated that they were about to learn a new language game. They were told that in order to play the game, they first needed to learn the rules of the game. Once they had seen the rules (the exposure phase), they moved on to the actual game (the test phase).

Learning the rules of the game actually meant exposing the participants to a velar palatalization pattern triggered by suffixation marking gender and number agreement. The participants were first shown a picture of a boy or a girl performing an action. Underneath the picture a nonce word was written in capital letters. For instance:

(11)

![Image](image)

ŽОК
[ʒok]

The next slide presented three boys or girls performing the exact same action. Underneath that picture, the following sentences were written: ‘I say X’… ‘You say X’ (where X stands for a nonce word). The participants were asked to repeat out loud the second nonce word, i.e. the one that appeared after ‘You say’.

(12)
The idea behind this was to expose the participants to the suffixation marking gender and number agreement, which triggers palatalization of the voiceless velar [k]. This rule was the rule of the language game (non-existent in Serbian) that the participants were supposed to observe and then by analogy apply in the test phase. All of the picture pairs involved first a picture of a single actor performing an action (singular) and then a picture of three actors performing the exact same action (plural). The suffix on the verb appeared in the plural instances only. All of the pictures in the [e] condition group were pictures of boys ([eta] mapped to male gender), whereas all of the pictures in the [i] condition group were pictures of girls ([ita] mapped to female gender).

After the exposure phase (consisting of 40 nonce verbs), the participants were given a short break. During the break, they were asked to answer 10 questions that were considered relatively easy for their age. The questions were typed on a piece of paper and the participants wrote down their answers. The questions for children were taken from the children’s magazine Malac Radoznalac designed for children 7 to 9 years of age. The questions for adults were taken from the quiz Ko želi da postane milijoner ‘Who wants to become a millionaire’. There were two types of tasks in the break phase, which mapped to the type of the task in the test phase. When the participants were about to do a gap task in the test phase, they were given a gap task in the break phase as well; likewise, when they were about to do a choice task in the test phase, a choice task was given to them in the break phase. In order to be consistent with the test phase, the participants were given a choice of three possible answers in the break phase as well. The break-phase questions in the two types of tasks were different. The purpose of the break phase was to keep the participants ‘intellectually’ occupied so that they did not dwell on the data provided in the exposure phase. Once the participants finished answering the questions, they turned in their answers to the experimenter.

The break phase was followed by a test phase. The same participants did both types of tasks with the same stimuli in both exposure and test phase on two different occasions. The gap task was performed first. It was followed by a choice task a few days later. The order that the two types of tasks were performed was such so that the potential bias from the choice task (which included given answers) would be avoided. The same stimuli were used in both types of tasks in order for the results to reflect the influence of the tasks only and not the stimuli. There was a few days break in between the two types of tasks and this was done so that the participants would ‘forget’ the stimuli they were exposed to.

In the gap task, the participants were asked to fill in the gap in ‘You say X’ with whatever they found correct, for instance:

(13) Ja кажем ЖОКЕТА. Ти кажеш ...
[ja ka3em 3oketa] [ti ka3ef]
I say You say

An example for [i] condition group would be [ja ka3em 3okita] – [ti ka3ef 3ofita].
They were asked to say their responses out loud and the experimenter wrote down the responses. Just like in the first experiment, this was done to facilitate automatic responses.

In the choice task, the participants were given three forms out of which they were supposed to pick out only one they considered ‘correct’:

(14)  

\[
\begin{array}{ll}
\text{Ja} & \text{kажем ЖОКЕТА.} \\
\text{[ja kaʒem ʒoketa]} & \text{Ти кажеш а. ЖОКЕТА [ʒoketa]} \\
\text{I say} & \text{You say в. ЖОЧЕТА [ʒoteta]}
\end{array}
\]

When the participants decided which form they found ‘correct’, they told their choice to the experimenter, who wrote down the response. After the participants uttered the chosen form, they clicked on the space button on the laptop to move to the next slide.

In the test phase, both condition groups, [i] and [e], encountered suffixes with different initial vowels: [i], [e] and [a]. The [i] initial suffix mapped to the female gender, the [e] initial suffix to the male and the [a] initial suffix to a mixture of male and female actors.

5.4. Results

There were slight differences in the results obtained from the two age groups but overall, children and adults behaved very similarly. The results reveal differences in behavior between the two condition groups in that the groups exposed to [i] palatalization very infrequently generalized palatalization to the mid front vowel [e] in both types of tasks (the finding which confirms the naturalness hypothesis); however, the groups exposed to [e] palatalization behaved differently depending on the type of the task. The participants did not generalize palatalization to the high front vowel [i] in the gap task (contradicting the naturalness hypothesis) whereas they did in the choice task (confirming the naturalness hypothesis).

5.4.1. Gap task: Adults and Children

The adults’ responses from both condition groups in the gap task are summarized in Table 3 below. Notice that the vowel contexts are labeled as [ki], [ke] and [ka] and the group exposed to the high front vowel is labeled [i]-group and the one exposed to the mid front vowel is labeled [e]-group.

Table 3
Experiment 2. Responses of Adults in Gap task

<table>
<thead>
<tr>
<th></th>
<th>[ki] (10)</th>
<th>[ke] (10)</th>
<th>[ka] (10)</th>
<th>filler (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[i]-group</td>
<td>[e]-group</td>
<td>[i]-group</td>
<td>[e]-group</td>
</tr>
<tr>
<td>palatalized</td>
<td>98.6%</td>
<td>4.7%</td>
<td>5.3%</td>
<td>97.3%</td>
</tr>
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<td></td>
<td>3.3%</td>
<td>0.7%</td>
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<td>0%</td>
</tr>
<tr>
<td>non-palatalized</td>
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</tr>
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</tr>
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</tr>
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<td></td>
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</tbody>
</table>

The children generally exhibit the same behavior as the adults. Their responses are summarized in Table 4 below.

Table 4
Experiment 2. Responses of Children in Gap task

<table>
<thead>
<tr>
<th></th>
<th>[ki] (10)</th>
<th>[ke] (10)</th>
<th>[ka] (10)</th>
<th>filler (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[i]-group</td>
<td>[e]-group</td>
<td>[i]-group</td>
<td>[e]-group</td>
</tr>
<tr>
<td>palatalized</td>
<td>98.6%</td>
<td>4.7%</td>
<td>5.3%</td>
<td>97.3%</td>
</tr>
<tr>
<td></td>
<td>3.3%</td>
<td>0.7%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>non-palatalized</td>
<td>1.4%</td>
<td>95.3%</td>
<td>89.4%</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>92%</td>
<td>98%</td>
<td>100%</td>
<td>99.3%</td>
</tr>
<tr>
<td>other</td>
<td>0%</td>
<td>0%</td>
<td>5.3%</td>
<td>0.7%</td>
</tr>
<tr>
<td></td>
<td>4.7%</td>
<td>1.3%</td>
<td>0%</td>
<td>0.7%</td>
</tr>
</tbody>
</table>
Overall, the results of the [i]-condition groups confirm the naturalness hypothesis; i.e. the participants palatalized before the high front vowel [i] but did not generalize palatalization to the mid front vowel [e] context. However, the results obtained from the [e]-condition groups do not support the naturalness hypothesis. The participants applied palatalization before the mid front vowel [e] but failed to generalize palatalization to the high front vowel [i] context. The results of each of the condition groups are discussed in detail below.

5.4.1.1. Adults and Children exposed to [i]

The adults and children in the high front exposure condition, i.e. [i], applied palatalization to the voiceless velar stop before the high front vowel consistently in the gap task: 98.6% and 98% of the time respectively. No other sound change except velar palatalization occurred as a response.

In the novel context, the mid front vowel [e], a significant number of responses included the non-palatalized form, 89.4% for adults and 86.6% for children. The palatalized responses occurred rarely: 5.3% of the time for adults and 8% for children. The number of such responses is not large and as such does not interfere with the overall implications that the results reveal. A large percentage of non-palatalized responses clearly indicates that [i] palatalization was not generalized to [e]. The small percentage of palatalized and random sound change responses (5.3% for adults and 5.4% for children) is considered noise.

Palatalization was also largely not generalized to the back vowel [a]. Palatalized responses occurred 3.3% of the time for adults and 2.8% of the time for children while the random sound change ones occurred 4.7% of the time and 8.6% of the time respectively.

As for the fillers, they were unanimously not changed (100%) for adults whereas children applied random sound change 10% of the time. Again, the great majority of responses that were not changed tell us that both age groups (adults and children) systematically followed the phonological process of velar palatalization as the only sound change.

5.4.1.2. Adults and Children exposed to [e]

For the adults exposed to the [e] palatalization condition, the great majority of responses before the mid front vowel [e] were palatalized (97.3%), a very small number were not palatalized (2%) and an even smaller number exhibited a random sound change (0.7%).

The children exposed to [e] palatalization largely chose the palatalized form in the mid vowel context (72%). The non-palatalized response appeared 19.3% of the time; and a random sound change 8.7%. It can be concluded then that both adults and children followed the palatalization pattern well and applied it accordingly in the test phase.

The results obtained in the high front vowel context are extremely interesting. The adults failed to generalize palatalization from the mid to the high front vowel context to a large extent. Only 4.7% of the responses were palatalized. Children behaved very similarly and palatalized only 2.7% of the time. They did however apply a random sound change 16% of the time. Even though there is some noise among these results, they suggest that the children failed to generalize palatalization to the high front vowel in the gap task.

Furthermore, palatalization was not generalized to the back vowel [a] where it applied only 0.7% of the time for adults and 1.4% of the time for children. Random sound change responses rarely occurred
(1.3%) for adults. However, it is worth noting here that 21.3% of the time (marked as ‘random’ in the Table 4), the children did not use the suffix presented to them, for instance [ati], but rather used the suffix that they learned in the exposure phase, for instance [eti]. All taken into consideration, both adults and children did not generalize palatalization to the back vowel [a].

The fillers were largely not changed for adults (99.3%). The children tended not to change them as well (85.3%). A random sound change appeared 0.7% of the time for adults and 14.7% of the time for children. The children responses present some noise but overall, the results obtained from both age groups indicate that the participants systematically applied only one phonological change, velar palatalization, and therefore for the most part they did not change the fillers.

To sum up, the two condition groups (both children and adults) in the gap task differ in their responses for the mid and high front vowel contexts. The [i] group largely did not generalize palatalization to the mid front vowel [e] and the [e] group largely did not generalize to the high front vowel [i]. In other words, both of the condition groups applied the pattern that they were exposed to but failed to generalize the pattern to the novel vowel contexts. The high front [i] exposure group conformed to the naturalness hypothesis and did not generalize to the mid vowel [e]. However, the mid front [e] exposure group conformed to the native language pattern and did not generalize palatalization from the mid to the high front vowel disproving the naturalness hypothesis.

As mentioned earlier, the results from the choice task differ in that they overall support the naturalness hypothesis; i.e. both condition groups (high and mid front vowel) behaved in accordance with the predictions of the naturalness hypothesis: the groups exposed to [i] palatalization generally did not extend the pattern to [e] whereas the groups exposed to [e] generalized palatalization to [i]. These results are presented in the following section.

5.4.2. Choice task: Adults and Children

The choice task involved the exact same stimuli as the gap task. The difference between the two types of tasks is the following: the participants were given three possible answers in the choice task but no choices were provided in the gap task. Hence, it could be said that the choice task biased the participants and restricted their responses whereas nothing similar happened in the gap task. It is for this reason that the choice task was carried out a few days after the gap task with the exact same participants. In the choice task, the participants were asked to choose only one of the three provided answers that they considered to be a ‘correct’ one. The results obtained from both condition groups in the choice task support the naturalness hypothesis: the participants generalized from the mid to the high front vowel context and they did not do so from the high to the mid front vowel context.

Let us now look at the results obtained from both age groups (adults and children) in both conditions (mid and high front) in the choice task. Table 5 below summarizes results obtained from adults and Table 6 from children.

<table>
<thead>
<tr>
<th>Table 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 2. Responses of Adults in Choice task</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>[ki] (10)</th>
<th>[ke] (10)</th>
<th>[ka] (10)</th>
<th>filler (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[i]-group</td>
<td>100%</td>
<td>96%</td>
<td>11.3%</td>
<td>100%</td>
</tr>
<tr>
<td>[e]-group</td>
<td>2.8%</td>
<td>8%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>palatalized</td>
<td></td>
<td></td>
<td>96.6%</td>
<td>92%</td>
</tr>
<tr>
<td>non-palatalized</td>
<td></td>
<td></td>
<td></td>
<td>96%</td>
</tr>
<tr>
<td>other</td>
<td></td>
<td></td>
<td></td>
<td>96.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.4%</td>
</tr>
</tbody>
</table>

Table 6
Experiment 2. Responses of Children in Choice task

<table>
<thead>
<tr>
<th></th>
<th>[ki] (10)</th>
<th>[ke] (10)</th>
<th>[ka] (10)</th>
<th>filler (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[i]-group</td>
<td>[e]-group</td>
<td>[i]-group</td>
<td>[e]-group</td>
</tr>
<tr>
<td>palatalized</td>
<td>98%</td>
<td>80%</td>
<td>17.3%</td>
<td>100%</td>
</tr>
<tr>
<td>non-palatalized</td>
<td>0.6%</td>
<td>20%</td>
<td>80%</td>
<td>0%</td>
</tr>
<tr>
<td>other</td>
<td>1.4%</td>
<td>0%</td>
<td>2.7%</td>
<td>0%</td>
</tr>
</tbody>
</table>

The results of each of the condition groups are discussed in detail below.

5.4.2.1. Adults and Children exposed to [i]

The adults exposed to [i] palatalization invariantly applied palatalization in the high front vowel context in the choice task (100%). The children showed very similar behavior: they palatalized in the high front vowel context 98% of the time. This strongly suggests that the pattern the participants were exposed to was mastered and applied (almost) perfectly.

The mid front vowel context [e] yielded mostly non-palatalized responses (88% for adults and 80% for children). Palatalized responses occurred 11.3% of the time for adults and 17.3% of the time for children. Even though these responses are not so infrequent, they will be considered noise since statistical analysis (presented below) shows that there is no significant effect. The overall generalization is that the participants did not generalize palatalization from the high to the mid front vowel.

Also, palatalization was not generalized to the back vowel [a]. Non-palatalized responses occurred 96.6% of the time for adults and a little bit less for children, 87.3% of the time. Palatalized responses were rare (2.8% for adults and 4.7% for children). Random sound change responses were also infrequent (0.6% and 8% of the time for adults and children respectively). Thus, it could be concluded that the participants did not generalize palatalization from the high front vowel to the low back vowel.

The adults rarely changed the fillers, only 4% whereas children changed them 15.4% of the time. The much greater majority of non-changed responses tell us that both adults and children generally did not apply random sound changes to the fillers and were systematically applying only velar palatalization.

5.4.2.2. Adults and Children exposed to [e]

Both adults and children exposed to [e] palatalization unanimously applied palatalization in the mid front vowel context (100%). Interestingly, both age groups largely generalized palatalization to the high front vowel (96% for adults and 80% for children). The non-palatalized form was chosen only 4% of the time among adults and 20% of the time among children. A random sound change was never a response in both age groups.

Palatalization was not generalized to the back vowel [a]; palatalization applied only 4.7% of the time for adults and 8% of the time for children. The adults chose a random sound change 1.3% of the time whereas there were no random sound change responses among children.

The fillers were mostly not changed among adults (96.6%). The children had a tendency not to change the fillers (84%) but there was some noise (16%).

To sum up, in the choice task, both the children and the adults exposed to [i] failed to generalize to the mid front vowel, and both age groups exposed to [e] palatalization did generalize the pattern to the high front vowel [i] conforming to the phonetically natural pattern. Therefore, both condition groups in the choice task behaved as the naturalness hypothesis predicts: the high front condition group did not generalize to the mid front vowel context and the mid front condition group did generalize to the high front vowel context.
For the cases where the participants palatalized \([k]\), we conducted a by-subject ANOVA with the vowel ([i], [e], [a]) and task (gap, choice) as within-subject factors, and with age (children vs. adults) and exposure ([i] vs. [e]) as between-subject factors. We found no significant difference between the groups as far as age is concerned (\(F(1, 59)= 0.937, p=.337\)). This shows that both age groups exhibited more or less the same behavior and age did not play any crucial role in this experiment. We found a significant interaction of vowel and exposure effect (\(F(2, 58)= 803.234, p<.0001\)). The data suggest that when the participants were exposed to [e], they palatalized before [i] or [e] but not before [a], whereas when the participants were exposed to [i], they palatalized only before [i].

For the cases where the participants chose a random sound change, we conducted a by-subject ANOVA with the vowel ([i], [e], [a]) and task (gap, choice) as within-subject factors, and with age (children vs. adults) and exposure ([i] vs. [e]) as between-subject factors. We found a significant age effect (\(F(1, 59)= 7.335, p=.009\)). This suggests that the two age groups exhibited different behavior, where the children chose random sound change responses more than the adults. We also found a significant vowel effect (\(F(1, 59)= 11.618, p<.001\)), which means that different vowels triggered different responses. No significant exposure effect was found (\(F(1, 59)= .293, p=.590\)). This suggests that both exposure groups behaved more or less the same.

As the results above show, there are no big differences in the critical item responses obtained from the two different age groups. However, there is a huge discrepancy in generalizing the palatalization from the mid to the high front vowel depending on the type of the task. Such a discrepancy is not encountered in generalizing the palatalization from the high to the mid front vowel. The next subsection compares the results obtained from the gap and choice task.

### 5.4.3. Comparison of Results: Gap and Choice

Table 7 and 8 below summarize the responses from the mid front condition groups and the two tasks.

#### Table 7

**Experiment 2. Adults exposed to [e]: Gap and Choice**

<table>
<thead>
<tr>
<th></th>
<th>[ki] (10)</th>
<th>[ke] (10)</th>
<th>[ka] (10)</th>
<th>filler (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>gap</td>
<td>choice</td>
<td>gap</td>
<td>choice</td>
</tr>
<tr>
<td>palatalized</td>
<td>4.7%</td>
<td>96%</td>
<td>97.3%</td>
<td>100%</td>
</tr>
<tr>
<td>non-palatalized</td>
<td>95.3%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>other</td>
<td>0%</td>
<td>0%</td>
<td>0.7%</td>
<td>0%</td>
</tr>
</tbody>
</table>

#### Table 8

**Experiment 2. Children exposed to [e]: Gap and Choice**

<table>
<thead>
<tr>
<th></th>
<th>[ki] (10)</th>
<th>[ke] (10)</th>
<th>[ka] (10)</th>
<th>filler (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>gap</td>
<td>choice</td>
<td>gap</td>
<td>choice</td>
</tr>
<tr>
<td>palatalized</td>
<td>2.7%</td>
<td>80%</td>
<td>72%</td>
<td>100%</td>
</tr>
<tr>
<td>non-palatalized</td>
<td>81.3%</td>
<td>20%</td>
<td>19.3%</td>
<td>0%</td>
</tr>
<tr>
<td>other</td>
<td>16%</td>
<td>0%</td>
<td>8.7%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Both age groups failed to generalize from the mid to the high front vowel in the gap task, while they did generalize in the choice task. These responses are shown in the first two columns of the Tables 7 and 8. The [i] environment is the most intriguing one since the responses of both age groups drastically differ in two types of tasks. In the gap task, where the participants were asked to produce a form that they
thought was a correct one, they did not palatalize before the high front vowel [i]. On the other hand, when
the participants were asked to choose one of the provided forms (choice task), they chose the ones in
which the voiceless velar [k] underwent palatalization before the high front vowel [i]. These results raise
some interesting questions about the naturalness hypothesis since it holds in one type of task (choice) and
not in the other (gap).

In contrast, both age groups exposed to [i] palatalization in the exposure phase very infrequently
generalized palatalization to the mid front vowel [e] in both types of tasks. Such results are in accordance
with the naturalness hypothesis. The responses of both age groups exposed to [i] palatalization are
summarized in Tables 9 and 10 below:

<table>
<thead>
<tr>
<th>Table 9</th>
<th>Experiment 2. Adults exposed to [i]: Gap and Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[ki] (10)</td>
</tr>
<tr>
<td></td>
<td>gap</td>
</tr>
<tr>
<td>palatalized</td>
<td>98.6%</td>
</tr>
<tr>
<td>non-palatalized</td>
<td>1.4%</td>
</tr>
<tr>
<td>other</td>
<td>0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 10</th>
<th>Experiment 2. Children exposed to [i]: Gap and Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[ki] (10)</td>
</tr>
<tr>
<td></td>
<td>gap</td>
</tr>
<tr>
<td>palatalized</td>
<td>98%</td>
</tr>
<tr>
<td>non-palatalized</td>
<td>2%</td>
</tr>
<tr>
<td>other</td>
<td>0%</td>
</tr>
</tbody>
</table>

Contrary to the [e]-exposure groups, [i]-exposure groups behaved almost identically in both types
of tasks (the second two columns of the Tables 9 and 10); i.e. the responses to the mid front vowel
environment obtained from the [i] groups in both gap and choice type of task are both largely non-
palatalized.

For the cases where the participants palatalized the velar [k], we conducted a by-subject ANOVA
with the vowel ([i], [e], [a]) and task (gap, choice) as within-subject factors, and with age (children vs.
adults) and exposure ([i] vs. [e]) as between-subject factors. We found that the interaction of vowel,
exposure and task was significant (F(2, 58) = 207.332, p<.0001), which means that when the participants
were exposed to [e], they palatalized before [i] only in a choice task while they did not in a gap task.

For the cases where the participants chose a random sound change, we conducted a by-subject
ANOVA with the vowel ([i], [e], [a]) and task (gap, choice) as within-subject factors, and with age
(children vs. adults) and exposure ([i] vs. [e]) as between-subject factors. We found that there was a
significant task effect (F(1, 59) = 7.373, p=.009), which shows that the type of task yielded different
responses.

These results suggest that in an artificially learned pattern context, age does not play an important
role. Both adults and children exhibited more or less the same behavior. However, what matters is the
vowel that appears in the exposure phase ([i] or [e]) and the type of the task (gap or choice) in
generalizing the pattern to novel vowel contexts. In the high front exposure group the type of the task did
not play a crucial role though and the results are in accordance with the naturalness hypothesis:
palatalization failed to generalize from the high front vowel [i] to the mid front vowel [e]. However, in the
mid front exposure group, the type of the task played a crucial role. The gap task yielded responses
showing that the native language pattern is favored over the phonetically natural one (palatalization before the mid front [e] fails to generalize to the high front [i]). The choice task, on the other hand, showed that the phonetically natural pattern is favored over the native language one (palatalization before the mid front [e] generalizes to the high front [i]).

6. Discussion

The questions that led to the experiments were the following: (1) is the native language pattern a learned pattern that ‘overwrites’ the phonetically natural one; (2) is it a productive pattern, i.e. does it apply only to existing verbs in Serbian or does it extend to new verbs as well; and (3) does the pattern apply only in a native language context or in artificially learned patterns as well.

The hypothesis in the first experiment was that the children would follow the phonetically natural pattern while the adults would not. The reasoning behind this hypothesis lies in the temporal difference in exposure to the native language pattern. The adults were expected to be biased towards the native language pattern given that they had sufficient exposure to master the grammar of the language; whereas the children were expected to follow the phonetically natural pattern at least to some extent since they had less exposure to the native pattern than adults. And the results confirmed the expectations: in general, the children favored the phonetically natural pattern, the adults the native language one. The children, while still in the process of acquiring the native language pattern, do what seems to be most natural to them. Also, the experiment showed that for the adults the native language pattern of palatalization is productive since it applies to new verbs.

Further, the first experiment illuminated some issues that need further investigation. One of them concerns age and its importance in acquiring the native language pattern. The children that participated in this experiment were from 7 to 9 years of age, which makes them competent speakers of the language, and yet they exhibited behavior that favors a pattern different from the one that exists in the language. One might wonder what the critical age or the amount of exposure is in acquiring the native pattern and cutting off the phonetically natural one. Further, some responses among adults included the palatalized form before the high front vowel [i] and even though such responses were not numerous (22%), this raises the question of whether adults do have a phonetically natural pattern though it may not be as strong as the native language pattern.

The second experiment tested how biased Serbian native speaking children and adults were towards the native language pattern once they were taught a new palatalization pattern. Here, in contrast to the first experiment, results did not differ according to age of participants. The relevant factors are the vowels that the participants were exposed to ([i] or [e]) and the two types of tasks (gap and choice). These factors and their interaction yielded some striking differences in the responses.

The responses obtained from the high front condition group are exactly what the naturalness hypothesis predicts. Generalization to the mid front vowel [e] rarely occurred in both age groups regardless of the type of task. It is worth noting, though, that once participants were given a choice, more palatalized responses appeared. Such a finding might be explained by assuming that when palatalized forms are presented as an option, they activate similar palatalized forms found in the participants’ native language, and therefore are more likely to be chosen. Overall, the [i] condition group confirmed the naturalness hypothesis and showed that the native language pattern did not interfere with the newly learned pattern that the participants were exposed to.

The mid front condition group behaved as predicted by the naturalness hypothesis in the choice task but completely unexpectedly in the gap task. The participants generalized palatalization to the high front vowel [i] when they were presented with choices but failed to do so when they were asked to produce the new form. It is important to highlight here that the pattern the participants were taught is the one they already have in their language (palatalization before [e] in verbal inflectional morphology, such as present tense marking shown in experiment 1). Even though this is a particular morpho-syntactic context, it seems to be strong when the same lexical category (verbs) and the same type of morphology
(inflectional) are at play. This native language pattern ‘overwrote’ the phonetically natural one only in the gap task in the mid front condition group.

These results are opposite of the ones obtained from the same mid front condition group in the choice task. Both children and adults favored the phonetically natural pattern when given a choice. Note that these results shed some light on the results of the first experiment. When the adults did the same type of task (choice) in the first experiment, which involved their native language, they favored the native language pattern (no palatalization before [i]). The children, on the other hand, behaved the same in both experiments (palatalization before [i]). It could be the case that the children who participated in the first experiment had still not acquired the native language pattern of their language and therefore relied on the phonetically natural one. The children from the second experiment did the same. Strikingly, though, when the children were given a gap (no choices provided), they followed the rules of their language; that is, the rules that are specific to lexical category of verbs and inflectional morphology among them. Since the first experiment did not include the gap task, it is hard to say whether the children would conform to the native language pattern but it is still possible to hypothesize that they would, based on the results from the second experiment.

On the other hand, the adults seem to have been aware what language they were operating in. In the first experiment, they largely chose the native language pattern of palatalization (palatalization before [e] and not before [i]). In the second experiment, in the gap task, the adults from the mid condition group followed the native language pattern as well. However, in the choice task, they favored the phonetically natural option (palatalization before both [e] and [i]). While the same explanation as the one given for the children could account for the gap task results, the choice task results remain unexplained. Interestingly though, these results strengthen the assumption (Wilson 2006, Moreton 2008, Hayes et al. 2009) that subjects are more likely to choose a phonetically natural form presented to them than to volunteer it; i.e. once subjects are presented with a choice, the phonetically natural bias wins over the native language one. However, the findings from this experiment call for further research on palatalization and the factors that shape different responses (vowels in the exposure phase, type of task) before a full explanation can be provided.

7. Conclusion

The two experiments reported in this paper tested the naturalness hypothesis of palatalization in different contexts. The main questions that were addressed are (1) whether the existing palatalization pattern in Serbian verbal inflectional morphology is stronger than the phonetically natural one, (2) whether this native language pattern is productive in Serbian and (3) whether the pattern would surface in both native language context and an artificially learned pattern. The first experiment was set in the native language context and the second one was an artificial language learning experiment. The results from the first experiment show that the children favor the phonetically natural pattern whereas the adults favor the native language one. This experiment showed that the age plays a crucial role.

The results of the second experiment for the mid condition groups (both children and adults) differ depending on the type of the task: gap or choice. Both age groups in gap task followed the native language pattern, invalidating the naturalness hypothesis whereas in choice task, they followed the phonetically natural pattern. The results for the high front condition group validated the naturalness hypothesis in both types of task for both age groups. Such findings, the implications of which need to be further investigated and explained, show that the age is not a critical factor in an artificially learned pattern context but rather type of task and vowel exposure. The factors shown to be critical in both experiments as well as their interaction need further research before a better explanation of the findings obtained can be provided.

References


