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Lexical access in Bulgarian perfective vs. imperfective verbs (extended version)

(extended version of the paper presented at the 9th International Morphology Meeting, Vienna 2000; to appear in the proceedings)

The goal of the two experiments reported on in this paper is to compare the behaviour of different classes of Bulgarian verbs with respect to their lexical access properties. In experiment I, we compared two sets of words (class 1 and 2), comprising an equal number of 'perfective' and 'imperfective' forms; in addition, the two sets were also divided into frequent and rare verbs. The imperfective forms in class 2 were slightly more complex than those of class 1 in terms of the morphophonological process deriving them from their perfective counterparts. The experimental paradigm adopted was repetition priming with visual lexical decision. All targets consisted of the 2nd. sg. Future form of the 'perfective' verb, while the primes (besides those coinciding with targets in the 'identity' condition) were the 3rd sg. Future of the perfective ('inflected' primes) and the 2nd sg. Future of the imperfective ('derived' primes). Experiment II was based on the same design as experiment I, with the exclusion of the frequency factor, and with replacement of class 1 verbs with verbs of class 3, where the morphophonological complications were further enhanced.
The expectation, based on previous research relating to other Slavic languages, was that the priming advantage of inflectionally related forms should be larger than that of derivationally related forms. Our results suggest that this is only partly true: in fact, this result emerged to some extent only within words of class 3. On the other hand, experiment I (besides confirming the fundamental role of the frequency factor) yielded a reliable contrast between class 1 and 2, most probably due to the morphological compositionality to be observed in class 2 words as opposed to class 1.*

1. Introduction.

One of the major issues in contemporary psycholinguistic research concerning lexical access is the long-debated problem of compositionality vs. non-compositionality in the processing of morphologically complex forms. The compositional approach involves access to the single

* We wish to thank Maddalena Agonigi, who assisted us with the experimental software and with the statistical analyses. We are also indebted to Cristina Burani and Alessandro Laudanna for their useful comments and guidance in the early phase of this research. A special thank is due to Laurie Feldman, who provided us with the experimental list of her Serbo-Croatian experiment, allowing us to exploit the guidelines of her research. The first author acknowledges the Research Support Scheme of the Open Society Support Foundation (grant No.: 669/1998).

morphemes that constitute the intended form, in order to check for compatibility between base and affixes. To perform this checking, the cognitive system must be endowed with the appropriate rule machinery, in order to generate all and only the correct words of the language. The non-compositional view involves instead direct access to the intended form, which is considered to be permanently stored in the mental lexicon. Although both approaches have been advocated in their extreme versions, most scholars would now agree that both routes of access to the internal lexicon are viable, the difference lying in the particular subset of the lexicon involved. In a recent review of the topic, Bertinetto (1995) provided the following tentative summary:

a) Derived forms are less likely to be rule-governed than inflected forms;
b) Non-productive forms are less likely to be rule-governed than productive forms;
c) Phonotactically and semantically opaque forms are unlikely to be rule-governed, whereas transparent forms may be;
d) Irregular forms are unlikely to be rule-governed, whereas regular forms may be;
e) Frequent forms are more likely to be directly accessed than non-frequent ones.

Although this pattern of data is fairly complicated, this is not all that one can say about it, for all the factors interact with one another, adding to the intricacy of the overall picture. As far as derivation is considered, for instance, one should distinguish between idiosyncratic and non-productive formations on the one side, and totally transparent and productive formations on the other side, where the latter are obviously more liable to be generated by rule than the former. In addition, one should also consider the typological inclinations of the various languages. Derived forms of agglutinating languages are more likely to be rule-governed than the corresponding forms of inflectional languages, for the number of possible formations in agglutinating languages is so high (also due to the regularity of the processes involved), as to make it definitely undesirable that all such forms be permanently stored in the mental lexicon.

Given this situation, it is not possible to assess the problem once and forever. Rather, the task consists in carefully accumulating diverse pieces of evidence, from as many languages as possible and from as many compartments of the lexicon as possible, in order to gradually build the global picture. The present paper presents some evidence from Bulgarian, a language so far scarsely explored in experimental psycholinguistics (but see Bertinetto & Jetchev 1996; Slabakova 1999; Nilkolova & Jarema 2000). The special interest of Bulgarian lies in the fact that this language, like all Slavic languages, presents two types of verbs, traditionally called 'perfectives' and 'imperfectives', which in most cases form derivationally related pairs. Actually, the label "derivationally related" should be interpreted with caution, for these pairs of verbs present characteristics which are not to be found in other instances of derivation. First, there is no part of speech shift: both members of the pair are verbs. Second, verbs belonging to a given aspectual pair form, so to say, a joint verbal paradigm, to the extent that some scholars would not even consider them derivationally, but rather inflectionally related (at least in languages like Russian, whose tense system is less rich than that of Bulgarian).[1] Although we do not agree with the latter view - for (specially in Bulgarian) we deal in these cases with two alternate sets of forms, each of them corresponding to a complete conjugational pattern - it is indeed the case that these verbal pairs constitute a very peculiar sort of derivational relationship. Consequently, the conclusions to be drawn from the present investigation, in terms of lexical access, are not directly applicable to other, more prototypical cases of derivation.

Note however that the specific type of derivational relationship under investigation here offers an obvious advantage over the most prototypical ones, for it may occasionally offer perfectly comparable counterparts, strictly equivalent on formal grounds. Indeed, the relationship may occasionally be based on competing forms sharing the same number of phonemes and syllables, with no stress shift. See for instance Rus. *slušat'* 'listen' vs. *slyšat'* 'hear' (as opposed to prototypical cases like It. *tradire* / *tradimento* 'betray / betrayal'). Thus, from the formal point of view, these pairs offer interesting opportunities. In addition, since there is a variety of morphophonological means to obtain the imperfective counterpart from a

1 Cf. Breu (1984) and Roussakova et al. (to appear). In the latter work, the behaviour of several groups of Russian subjects was tested in a task consisting in producing the Past tense of a verb using the 3rd sg. Present as a prompt. As it happens, in about 40% of the cases, subjects produced the wrong answer, i.e. produced the Past tense of the aspectually related verb. This percentage varied from case to case, and most notably from group to group. A quite surprising result was that 3 years old subjects were much more accurate than adult subjects. According to the authors, this indicates that for adult Russian speakers the tense forms of two aspectually related verbs merge often enough into a single "hyperparadigm".

perfective verb (or vice versa), it is possible to finely modulate the parameter of formal complexity, comparing the behaviour of different classes of aspectual pairs.

These morphological characteristics of Slavic verbs have already attracted the attention of Feldman (1994). In her experiment 3, she compared the behaviour of Serbian verbal pairs such as those exemplified in (1) below, where the formal equivalence of inflected and derived primes is strictly controlled for.[2] In fact, all primes and the targets share the same number of syllables and stress location. The results pointed to a significant facilitation produced by inflected - as opposed to derived - primes. This outcome is in agreement with previous works suggesting the relevance of the inflection / derivation divide, but has the additional advantage of avoiding the drawback of the formal mismatch between morphological cognates.

In this paper we report the results of two experiments performed on Bulgarian materials, designed in the same vein. In each experiment we compared the behaviour of two classes of verbs, differing from one another in terms of the morphophonological process deriving imperfectives from their perfective cognates. The details of these morphophonological processes will be given in the sections to follow. For the moment, it is worth drawing the attention to one experimental detail. Note that, in Feldman's work, derivationally related primes differed also inflectionally from their targets. Consider the design of her experiment 3, illustrated below by a typical set of examples:[3]

(1)

IDE: 3rd pl. Present pf. (*nose*)	TA: 3rd pl. Present Pf. (*nose*)
INF: 1st sg. Present pf. (*nosim*)	
DER: 1st sg. Present ipf. (*nosam*)	

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2 Actually, Feldman's experiment 3 presented also a set of 'mismatched' stimuli, where targets and identity primes had one syllable more than inflected and derived primes. In our replication of this experiment with Bulgarian materials, we ignored this further detail. It is worth observing that the pattern of results obtained by Feldman for mismatched words was rather different with respect to that obtained for matched words. In fact, contrary to expectations, inflected primes were significantly faster than identity primes, and no facilitation was found for inflected as contrasted with derived targets.

3 IDE = 'identical'; INF = 'inflected'; DER = 'derived'; TA = targets; pf = perfective; ipf. = imperfective.

§This design introduces an undesirable complication, for while inflected primes differ from targets by one factor only (inflection), derived primes differ by two factors (derivation and inflection). In fact, derivational primes change also the person (from 3rd pl. to 1st sg.). Thus, the comparison between inflected and derived primes may not be entirely fair. To overcome this flaw, in our experiments we adopted a different design, where both inflected and derived primes differed by just one factor (inflection or derivation, respectively). See the following set of examples, where s& is the Future (invariable) particle:[4]

(2)

ID: 2nd sg. Future pf. (s&obelis&)	TA: 2nd sg. Future pf. (s&obelis&)
IN: 3rd pl. Future pf. (s&obeljat)	
DE: 2nd sg. Future ipf. (s&te obels&)	

Should a statistically reliable difference be detected between targets following inflected vs. derived primes, this would be a stronger proof in favour of the alleged difference between inflection and derivation, to the extent of course that verb pairs of the Slavic type provide evidence for such a distinction.

2. Experiment 1.

2.1. Introduction.

For the purpose of experiment 1, we selected two classes of Bulgarian verbs, differing in terms of the morphophonological process deriving imperfectives from perfectives. Perfectives of class 1 belong to the /i/ conjugation (traditionally called 'second' conjugation), while imperfectives insert the infix /v/ before the inflectional ending, and - being 'derived' rather than primary - belong to the /a/, or 'third', conjugation. Thus, in addition to the change of conjugation, corresponding to a different thematic vowel, imperfectives are characterized by the insertion of one consonant, which also coincides with the insertion of a single grapheme, given the fairly shallow nature of Bulgarian orthography (see below for further comments on this topic). Perfectives of class 2, by contrast, belong to the /e/, or 'first', conjugation and are characterized by the presence of the infix

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[4] Note that our targets, as well as identical primes, could not coincide with the citation form - which in Bulgarian (a language without the Infinitive) is the 1st sg. Present Indicative - because with perfective verbs the latter is a non-autonomous form, only employed in dependent clauses introduced by a conjunction.

/n/ before the inflectional ending, while imperfectives (again 'derived', and thus belonging to the /a/ conjugation) change the infix /n/ into /v/. Here follows an illustration for each class, where the perfective verb is represented, as in (2) above, by 2nd sg. and 3rd pl. Future, while the imperfective verb is represented by 2nd sg. Future:[5]

- Class 1:	pf = *sæte obelæ/obeljat*	ipf = *sæ obelvasæ*
- Class 2:	pf = *sæte omeknæ / omeknat*	ipf = *sæ omekvasæ*

Obviously, the comparison between these two classes is meaningful only to the extent that the frequency factor is controlled for. In order to check this, we selected a fairly large number of candidates from each class, and submitted them to a panel of native speakers (all students in Sofia University) for subjective evaluation.[6] Subjects had to evaluate each item in a 5-point scale, where 5 meant "very frequent" and 1 "very rare", with 3 indicating medium range. On the basis of the subjective ratings, we selected four subclasses (each composed by 6 elements) by cross-cutting the 'aspect' and 'frequency' factors, thus obtaining eight perfectly balanced subclasses, as shown by the average frequency ratings reported below:

Class 1:	pf.:	frequent = 2.61	rare = 1.91
overall = 2.23	ipf.:	frequent = 2.58	rare = 1.99
Class 2:	pf.:	frequent = 2.51	rare = 1.94
overall = 2.27	ipf.:	frequent = 2.55	rare = 1.93

In this way, we were not only able to control for the frequency factor, but also to compare corresponding sets of frequent and rare verbs. The full list of forms is given in Appendix 1.

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5 It should be remarked that our identity primes did not coincide with the form that, in a language without Infinitive like Bulgarian, is considered to be the citation form, namely the 1st sg. of the Present. However, it was impossible to adopt this solution, for the perfective forms of the Present are non-autonomous, in that they are necessarily employed in dependent clauses (which implies the presence of a context introduced by a conjunction).

6 Subjects were asked to provide their judgements relative to 1st sg. Present forms, which are regarded as the citation forms in Bulgarian, a language lacking the Infinitive. This leaves the possibility that the forms actually tested in our experiment might have yielded a slightly different frequency judgement. However, since we used the same forms for all verbs, this risk may be considered negligible.

All verb forms were trisyllabic and stressed on the penultimate syllable. As to orthography, the average number of graphemes in each subclass was as follows:[7]

Class 1:	pf.:	frequent = 7	rare = 7.6
overall = 7.8	ipf.:	frequent = 8	rare = 8.6
Class 2:	pf.:	frequent = 8.6	rare = 8.2
overall = 8.4	ipf.:	frequent = 8.6	rare = 8.2

Altogether, class 1 words differed from class 2 words - with respect to orthography - on three counts. First, they were slightly shorter in the average. Second, perfective forms were exactly one grapheme shorter than their imperfective cognates, while no such difference was to be observed in class 2 words. Third, rare words of class 1 were slightly longer than frequent ones, while the reverse happened in class 2.

The experiment consisted in a repetition priming task with visual lexical decision. Subjects had to decide, as fast as possible, whether the stimulus appearing on the screen of a portable computer was a word or a non-word. The output of the decision process consisted in pressing one of two buttons, depending on whether the stimulus on the screen was a word or a non-word .

The design of the experiment was conceived in order to provide useful information as to the problem of lexical access with morphologically complex Bulgarian words. Specifically, the main goal of the test was to verify the results of Feldman's work on similar classes of Serbo-Croatian verbs. The expectations were the following:

(i) If morphological complexity is a relevant factor, there should be an advantage of inflected over derived targets;[8]

(ii) If morphophonological complexity is a relevant factor, there should be an advantage of class 1 over class 2;

(iii) If frequency is a relevant factor, there should be an advantage of frequent over rare items.

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7 Note that the transliteration <ja>, appearing in some forms of the 3rd pl. (as in (2) above), is not quite appropriate, because in the native orthography there is just one grapheme. Thus, in (2) identical and inflected primes consist of the same number of graphemes in the cyrillic alphabet.

8 By inflected and derived targets, one should understand targets connected with inflected and derived primes, respectively. In fact, as shown by the tables in sect. 1, all targets consisted in one and the same form for each verb.

Note, however, that the predicted stronger facilitation of inflected primes over derived ones could be regarded as less than obvious. In fact, although inflection presumably involves less processing than derivation, it is not without its own effects. Pickering & Branigan (1998) showed that the concomitant manipulation of number agreement - in a syntactic priming experiment - interacted to some extent with the dependent variable, consisting in building 'prepositional object' or 'double object' constructions on the basis of primes that preferentially suggested one of these alternatives. On the other hand, the concomitant manipulation of tense did not have the same effect. Since in our experiments the inflectional variable involved was person and number (rather than tense), our prediction was that inflection should present an advantage over derivation, but some disadvantage as compared to the identity condition.

2.2. Method.

Each class included 72 items, i.e. 12 identity primes, 12 inflected primes, 12 derived primes, plus 36 targets. Although the latter are formally identical to identity primes, they were in fact divided into identity, inflected and derived targets, depending on the type of primes they were associated with. In addition, each of these six subclasses was further divided into frequent and rare verbs (for instance: 6 frequent identity primes and 6 rare identity primes, and so on for the other subclasses). All in all, there were 144 word items (72 for class 1 and 72 for class 2).

The non-word items, in the same number as word items, were obtained by modifying a single consonantal phoneme of real words, chosen among those that were discarded as a result of the rating procedure. All items were phonotactically legal. The total number of words plus non-words was thus 288. Since non-words were obtained from words originally belonging to the same classes as those used in the experiment, they too were in principle subdivided in the same subclasses, with the obvious exception of the subclasses based on frequency (an irrelevant factor for non-words). Although this subdivision, in the case of non-words, has no direct bearing on our findings, it is worth mentioning it because it implies a very high density of the inflectional and derivational morphemes used in our experiment, thus enhancing the probability of triggering a decomposition procedure.

The prime / target distance was 10 words in the average, with a minimum of 8 and a maximum of 12. Since each subject could only respond to one target for each prime, we composed three partial lists, evenly distributing in each of them the various subclasses of items: words and non-words; class 1 and class 2 items; primes and targets (identity, inflected and derived); frequent and rare items. In the subsequent statistical analysis, we randomly grouped triples of subjects (one from each partial list), thus obtaining a set of 'supersubjects'. Each partial list consisted of 96 pseudo-randomized test stimuli (48 words, 48 non-words), plus 7 fillers, of which 2 at the beginning, to ensure a smooth start, and 5 towards the end of the list, in order to maintain the minimum distance of 8 intervening stimuli between primes and targets.

The subjects were 75, i.e. 25 in each group, all students in Sofia university and different from those who had taken part in the rating procedure. They were paid for their performance. Six subjects had to be discarded because of unsatisfactory performance, since the number number of errors exceeded the conventional threshold, i.e. exceeded the mean by more than twice the standard deviation. It should be noted, in this connection, that the number of errors was slightly increased by our decision to discard any response slower than 1000 milliseconds. When a slow response was detected by the software, a warning appeared on the screen, prompting subjects to speed up. On the other hand, we were lucky, in the sense that our six 'bad' subjects were evenly distributed among the three sublists, so that we had to discard not more than two supersubjects, whose final number was 23.

The hardware for the experiment consisted in a portable Mac computer and in a Superlab response box, developed by Hisham A. Abboud of Cedrus Corporation. The program of the experiment was taken care of by Dr. Maddalena Agonigi of Laboratorio di Linguistica of Scuola Normale Superiore. Each subject was run individually, according to the following procedure. First, the experimenter read the instructions, and gave additional explanations if necessary. Then, after orienting the response box so that the YES button was on the side of the preferred hand, the subject was introduced to the training session (consisting of 12 stimuli), in order to familiarize with the experimental setting. The training could be repeated on request; the actual experiment began when the subject felt ready. The presentation of each item was preceded by a warning acoustic signal and by the simultaneous appearance of a rectangular empty frame in the middle of the screen (devised in order to keep the fixation area stable), which remained visible for 500 msecs before the actual appearance of the stimulus.

The stimulus appeared right in the middle of this frame, and remained visible for 1000 msecs, at the end of which the screen remained blank for 2000 msecs.

Before performing the statistical analyses, we looked for primes that were not recognized as either words or non-words, depending on their specific nature. Following standard practice, we eliminated from further computations these data points, as well as the corresponding targets, for there is reason to assume that, in these cases, the priming process has not been fully activated. These misses (summing primes and related targets) were however fairly marginal: in all, we had to eliminate 453 observations out of 6624 (6.8%), including both words and non-words (no specific prime appeared to cause an exceeding number of misses). In addition, 82 responses (1.2%) were lost because of occasional malfunctioning of the hardware.

2.3. Results.

The mean reaction time (RT) for words, as opposed to non-words, was 685.6 vs. 756.7. This contrast was highly significant (Pr < 0.0001). Table 3 reports the mean RTs for the various subsets of word stimuli alone. The following general tendencies appeared (with << standing for "faster than", and < standing for "negligibly faster than"): targets << primes (659.9 - 710.8), frequent << rare (672.4 - 699.8); class 1 << class 2 (675.6 - 696.3); identity < inflected, inflected < derived (681.9 - 685.7 - 689.5). Note that the last weak tendencies were mainly due to primes (704.2 - 711.5 - 717.2) rather than targets (659.0 - 659.2 - 661.4).

With word items, we performed a series of ANOVA tests on the main factors and their interactions. The factors were: FUNCTION = prime / target; TYP = identity / inflected / derived; CLAS = class 1 / class 2; FREQUENCY = frequent / rare. The factors Function (by SS [= supersubjects]: 1, 44 = 17,57, Pr < 0.000; by items: 1, 142 = 55,47, Pr < 0.000) and Frequency (by SS: 1, 44 = 5,04, Pr = 0.030; by items: 1, 142 = 12,23, Pr = 0.001) were highly significant. Class was significant by items (1, 142 = 6,57, Pr = 0.011) but not by SS (1, 44 = 2,56, Pr = 0.116), while Type was non-significant altogether, as well as all the interactions. Of special relevance is the lack of significance of the Function * Type interaction; see the discussion in the next section.

A series of pair-wise *t*-tests showed that all comparisons between primes and targets were highly significant (in most cases, Pr < 0.0001). Besides, these tests reassessed the irrelevance of the Type factor. The differences between identity, inflected and derived was constantly non-significant, in contrast to Feldman (1994), where inflected and derived targets showed a significant divergence. On the other hand, a number of comparisons involving the two classes turned out to be significant: primes of class 1 vs. primes of class 2 ($Pr = 0.001$); targets of class 1 vs. targets of class 2 ($Pr = 0.002$); identity items (both primes and targets) of class 1 vs. identity items of class 2 ($Pr < 0.0001$); inflected items of class 1 vs. inflected items of class 2 ($Pr = 0.002$); identity primes of class 1 vs. identity primes of class 2 ($Pr = 0.022$). By contrast, the comparison between derived items of class 1 vs. derived items of class 2 turned out to be non-significant.

Table 3

Number of valid responses (italics) and mean RTs for W items of experiment I.

		N	RT		N	RT		N	RT
PRIMES	IDE	*487*	704.3	class 1	*248*	691.2	Freq	*128*	669.7
							Rare	*120*	714.1
				class 2	*239*	717.8	Freq	*123*	705.0
N = 1418							Rare	*116*	731.4
	INF	*477*	711.5	class 1	*251*	694.8	Freq	*130*	677.9
RT = 710.8							Rare	*121*	712.9
				class 2	*226*	730.1	Freq	*117*	728.3
							Rare	*109*	732.0
	DER	*454*	717.2	class 1	*232*	715.3	Freq	*122*	689.1
							Rare	*110*	744.3
				class 2	*222*	719.2	Freq	*111*	713.9
							Rare	*111*	724.9
TARGETS	IDE	*475*	659.0	class 1	*243*	648.5	Freq	*126*	634.4
							Rare	*117*	663.8
				class 2	*232*	670.0	Freq	*117*	657.0
N = 1387							Rare	*115*	683.3
	INF	*465*	659.2	class 1	*245*	645.5	Freq	*128*	636.8
RT = 659.9							Rare	*117*	654.9
				class 2	*220*	674.5	Freq	*116*	667.1
							Rare	*104*	682.7
	DER	*447*	661.4	class 1	*226*	658.5	Freq	*120*	641.7
							Rare	*106*	677.0
				class 2	*218*	664.5	Freq	*111*	653.5
							Rare	*107*	675.9

Table 4

Number of valid responses (italics) and mean RTs for W items of experiment II

		N	RT		N	RT
PRIMES	IDE	*297*	733.2	class 2	*149*	743.9
				class 3	*148*	722.4
N = 864	INF	*292*	747.9	class 2	*150*	731.9
				class 3	*142*	765.1
RT = 659.9	DER	*275*	756.5	class 2	*139*	757.5
				class 3	*136*	755.4
TARGETS	IDE	*290*	672.6	class 2	*146*	678.5
				class 3	*144*	666.5
N = 845	INF	*285*	684.6	class 2	*145*	699.5
				class 3	*140*	669.3
RT = 659.9	DER	*270*	689.5	class 2	*137*	682.3
				class 3	*133*	696.8

As to errors, a series of Wilcoxon tests were performed, assuming supersubjects as variance source. By 'error' we mean both misidentifications and slow responses. Note that in this analysis we included also the data points concerning non-identified primes, that were eliminated in the response analysis with their corresponding targets. For words and non-words together, the comparisons Word vs. Non-Word ($Pr = 0.0020$) and Prime vs. Target ($Pr < 0.0001$) turned out to be highly significant, while Class 1 vs. Class 2 only approached significance ($Pr = 0.641$). Among words alone, significance was found in the following comparisons: Prime vs. Target ($Pr = 0.0007$), Frequent vs. Rare ($Pr = 0.0001$) and Class 1 vs. Class 2 ($Pr = 0.0090$). No comparison was significant among the different types of target. By contrast, significance was found in the following two comparisons involving the two classes: primes of class 1 vs. primes of class 2 ($Pr = 0.0011$), inflected items (both primes and targets) of class 1 vs. inflected items of class 2 ($Pr = 0.052$). Thus, altogether, the error analysis yielded a pattern of results fairly similar to the one observed for the RT analysis.

2.4. Discussion.

The design of experiment I was conceived with the purpose of evaluating the lexical access mechanism in Bulgarian with respect to a selection of variables. In particular, we wanted to evaluate the role of:

(i) morphological complexity, opposing inflected and derived forms;

(ii) morphophonological complexity, opposing classes 1 and 2;

(iii) frequency, opposing frequent vs. rare verbs.

The statistical analyses performed on our data show that the first variable did not bring about the expected outcome. Namely, we did not find the expected interaction between the factors Function and Type, and specifically the expected significant facilitation of inflected targets over derived ones, contrary to Feldman (1994). It is not possible, at this stage, to decide whether this pattern of results corresponds to a fundamental homogeneity of inflectional and derivational processes in Bulgarian, as opposed to Serbo-Croatian (at least in the specific version in which derivation is implemented in the materials under analysis, where so-called 'aspectual pairs' are contrasted), or whether this was due to our particular selection of materials. We defer the problem until experiment II, reported below.

The high relevance of variable (iii), on the other hand, appears to be very straightforward, for frequency has long been known to have a strong impact on processing time.

As to variable (ii), it was only marginally significant in general, but various comparisons among specific subsets of the data turned out to be significant. It is worth observing that the significant contrast between identity primes of class 1 vs. identity primes of class 2 indicates that the two classes differed already at the level of first presentation of identity items, i.e. precisely those that - in the framework of our experiment - provided the 'base-line'.[9] Evidently, whatever makes the two classes different must be inherently present, as a characterizing feature, in these elements. By contrast, inflected and derived primes tended to converge, as suggested by the lack of significance of the comparisons between inflected (or derived) primes of class 1 and inflected (or derived) primes of class 2. This convergence was in fact so strong, that it emerged even in the (non-significant) comparison between derived items (both primes and targets) of class 1 vs. derived items of class 2.

However, the facilitation enjoyed by class 1 may be due to either one of the following factors: (a) morphological complexity; (b) length, as measured in phonemes\graphemes. In terms of factor (a), it should be noted that class 2 words, although involving a more complicated derivational process (based on the substitution of one phoneme\grapheme to another, rather than on the mere addition of a phoneme\grapheme), exhibited a more transparently 'motivated' morphological structure, in the sense that perfective items of class 2 contain the infix /n/, defining a sufficiently clearly identifiable set of perfective verbs (Radanova Kus[illegible]va 1995). As to factor (b), it should be recalled that class 1 items are on the whole shorter than class 2 ones (7.8 vs. 8.4). In order to check the impact of the length factor, we ran a multiple regression analysis of RT and Length with perfective primes (both identity and inflected) vs. imperfective primes (derived) of both classes, further divided by frequent and rare ones. The correlation between these two factors turned out to be fairly high (0.74; Pr = 0.0363). Indeed, a close inspection of the data concerning primes in table 3 in relation to their mean length (as indicated in section 2.1 above), reveals that RT and Length covary in most cases, with only two exceptions, both

9 Note that the privileged role of these elements was further enhanced by the very high frequency of the perfective 2nd sg. forms, manifested not only by identity primes but also by all types of target (thus by not less than 2/3 of the stimuli, including non-words).

concerning class 2: (i) rare perfective primes (identity and inflected) vs. frequent perfective ones; (ii) rare imperfective primes (derived) vs. frequent imperfective ones. Thus, with the partial exception of some data concerning class 2 and intersecting the Frequency factor, the variable Length seemed to play a considerable role in experiment I.

Both morphological complexity and length may therefore have had an impact on our results concerning classes 1 and 2. The problem will need reexamination in experiment II. Note however that, despite the significant role played by the Length factor, inflected primes of class 2 took longer to respond to, as compared with both identity and derived primes of the same class, although all items within each 'aspectual pair' of class 2 presented the same length.

Summing up the discussion so far, it is conceivable that the statistically reliable difference between classes 1 and 2, particularly striking in the case of identity primes, is either due to the presence of the /n/ infix in class 2 as opposed to class 1 (possibly involving an extra processing time for the native speaker), or to the length factor. On the other hand, there is no evidence of a contrast between inflection and derivation, at least in the specific version implemented in the materials tested in experiment I.

3. *Experiment II.*

3.1. *Introduction.*

A new set of materials were selected, while the general design of the test was kept as before. Specifically, class 1 items were replaced by new items (class 3; see the Appendix for the list of the materials used), while class 2 items were preserved. The characterizing features of class 3 are as follows. The perfective forms belong to the /e/ conjugation like those of class 2, but unlike those they are stressed on the inflectional ending. By contrast, the imperfective forms (belonging to the /a/ conjugation) are stressed on the root, and in addition present an array of morphophonological changes: 7 items change the second root vowel (in six cases: /e/ -> /'i/, in one case /e/ -> /'a/), while 5 items add a phoneme/grapheme (in two cases /'i/, in three cases /J/). Below we provide an example for each subtype, with perfective verbs represented, as in experiment I, by the 2nd sg. and 3rd pl. Future, and imperfective verbs by the 2nd sg. Future (for ease of the reader, we explicitly indicate the stress location):

/e/ -> /'i/:	pf. = s&te premes& / premetát	ipf. = s& premitas&
/e/ -> /'a/:	pf. = s&te«znesés&v«znesát	ipf. = s& v«znásjas&

/ø/ -> /'i/:   pf. = s&te provs&provrát   ipf. = s& provírasě
/ø/ -> /J/:   pf. = s&te naves&navedát   ipf. = s& navézasě

Thus, although the perfective forms of both classes 2 and 3 belong to the same conjugation, they differ in two ways. First, perfectives of class 2 are stressed on the penultimate syllable while those of class 3 are stressed on the last. Second, interspersed among the 12 perfective items of class 3 there are two disyllables (the remaining items being trisyllables), while all perfective forms of class 2 are trisyllabic. As to imperfective items of class 3, they are all trisyllabic and stressed on the penult, but they nevertheless differ from those of class 2 (and, for that matter, also from those of class 1) insofar as the morphophonological process deriving them is highly idiosyncratic, as opposed to the fairly regular pattern of class 2.

In order to control for the frequency factor, we selected a sufficiently large number of potential candidates from class 3 in order to submit them to a panel of native speakers (all students in Sofia university) for subjective evaluation, following the same procedure as before. We were thus able to isolate 24 items (12 perfectives and 12 imperfectives) that appear to be perfectly balanced with respect to those used in class 2, as shown by the average frequency ratings reported below, to be compared with those of class 2 exhibited in section 2.1. Note, however, that in this case we did not subdivide the two sets of verbs into frequent and rare ones, for we judged unnecessary to resubmit this factor to analysis, given the straightforward results obtained in experiment I:

Class 3:   overall = 2.35   pf. = 2.26   ipf.= 2.44

As to orthography, the average number of graphemes/phonemes in each set is as follows:

Class 3:   overall = 7.16   pf. = 6.66   ipf.= 7.66

With respect to orthography, class 3 items differ from class 2 items on two counts. First, they are more than one grapheme/phoneme shorter in the average. Second, perfective forms are exactly one grapheme shorter than their imperfective counterparts, while no such difference is to be observed in class 2 words.

The experimental design was the same as that of experiment I. The main expectations were as follows:

(i) If morphological complexity is a relevant factor, there should be an advantage of inflected over derived targets;

(ii) If morphophonological complexity is a relevant factor, there should be an advantage of class 2 over class 3;

(iii) If length is a relevant factor, there should be an advantage of class 3 over class 2.

3.2. Method.

All details are exactly as in experiment I. To sum up, there were 288 test stimuli, half of which were words. The word items were thus 144, i.e. 72 in each class (class 2 vs. 3), with 36 targets and 36 primes (12 identity, 12 inflected, 12 derived). Non-words, all phonotactically legal, were obtained by modifying a single consonantal phoneme of real words, chosen among those that were discarded as a result of the rating procedures relating to class 2 and class 3. Again, non-words were (at least in principle) subdivided into the same subclasses as words.

The prime / target distance was the same as in experiment I. Once again, we composed three partial lists, evenly distributing in each of them the various subclasses of items. For the purpose of the statistical analysis, we created a set of 'supersubjects' composed of one subject per group, in the same way as before. Each partial list consisted of exactly the same number of stimuli as in the previous case, again with the addition of 7 fillers in each list.

The subjects were 45 in all, 15 in each group, all students in Sofia university and different from those who had taken part in the scaling judgement or in experiment I. They were paid for their performance. Of these subjects, no one was discarded on the basis of insufficient level of performance (the criterion adopted was as before). The only difference in experimental procedure, compared with experiment I, was that the RT limit was raised to 1200 milliseconds. This allowed us to retain a few more responses. The number of responses discarded because of this was 167 (3.8%).

Before performing the statistical analyses, we looked for primes that were not recognized as either words or non-words, depending on their specific nature. We eliminated from further computations these data points, as well as the corresponding targets. The number of these misses was however fairly small: we eliminated 167 items out of 4320 (3.9%), including both words and non-words. No specific prime appeared to cause an exceeding number of misses. In addition, 98 responses (2.3%) were lost because of occasional malfunctioning of the hardware.

3.3. Results.

The mean RT for words, as opposed to non-words, was 714.2 vs. 775.7. This contrast was highly significant ($Pr < 0.0001$). Table 4 reports the figures for the various subsets of word stimuli alone. We observed practically no difference between class 2 and class 3 (712.5 vs. 715.7 msec.). By contrast, besides the obvious advantage of targets over primes (682 vs. 745.5 msec.), there was a tendency to an advantage - and an even stronger one - of identity over inflected items, and of the latter over derived items (703.2 - 716.6 - 723.3). This tendency was almost equally strong for primes (733.2 - 747.9 - 756.5) and for targets (672.5 - 684.6 - 689.5).

A series of ANOVA tests was performed - for word items only - on the main factors (Status, Function, Type, Class) and their interactions. The only significant factor was Function (by SS: 1, 28 = 12,108, $Pr = 0.002$; by items: 1, 142 = 69,916, $Pr < 0.000$). No other main factor or interaction was significant, including the interaction Function * Type.

A series of *t*-tests showed that all comparisons between primes and targets were highly significant ($Pr < 0.0001$), with the partial exception of the comparison between inflected primes and inflected targets of class 2 ($Pr = 0.045$). By contrast, no comparison involving the two classes was significant, just as no significant result was found in any of the pair-wise comparisons between the three types of target (considering class 2 and class 3 together). However, taking class 3 alone, there was full significance in the comparison between identity and derived targets ($Pr = 0.036$), while the comparison between inflected and derived targets approached significance ($Pr = 0.061$).

The error analysis was performed in the same way as in experiment I. For words and non-words together, only the following two comparisons turned out to be significant by supersubjects according to the Wilcoxon test: Prime vs. Target ($Pr = 0.0008$) and Identity vs. Inflected ($Pr = 0.0024$, collapsing primes and targets together). As to words, significance was found in the following comparisons: Prime vs. Target ($Pr = 0.0007$), Identity vs. Inflected ($Pr = 0.0063$) and Inflected vs. Derived ($Pr = 0.0037$). Furthermore, among targets alone, the only comparison approaching significance was that between identity and inflected targets in class 2 ($Pr = 0.0679$). Finally, in the comparisons involving the two classes, significance was merely approached in the case of identity items of class 2 vs. class 3 (Pr = 0.062). Thus, despite minor divergences between the RT and the error analyses, the general picture seems to be sufficiently consistent.

3.4. Discussion.

The main differences in the findings of experiment II, as compared to experiment I, were the following:

(a) no significant contrast was observed in the overall behaviour of the two classes ;

(b) considering class 3 alone, derived targets appeared to be significantly slower than identity targets, and very close to significantly slower than inflected targets.

Although the error analysis did not coincide with the RT analysis in the latter respect, this appears to be initial evidence for the claim that the degree of morphophonological complexity of class 3 is sufficiently high as to cause extra processing time for native speakers accessing the imperfective verbs from their perfective cognates. However, there seems to be no simple answer to the issues raised by points (i-ii) of sect. 3.1. The morphological and morphophonological factors intertwine to produce the observed pattern of results. Namely, it seems to be the case that morphophonological complexity has to overcome a certain threshold (as in class 3) in order for morphological complexity - as measured by the contrast inflected vs. derived - to yield significant effects.

As to point (iii), it is very unlikely that the disadvantage of derived targets of class 3 depends on the length factor (as measured in graphemes/phonemes). First, in class 3 the difference in length between imperfectives and perfectives is exactly the same as in class 1; yet, in the latter case no significant disadvantage was observed for derived primes. Second, if length were a relevant factor, we should observe an overall statistically significant contrast between class 2 and class 3, just as we did find it between class 1 and class 2 in experiment I: indeed, the mean length difference between class 2 and 3 is even larger than that between class 1 and 2. Since this was not the case, it follows that the different behaviour of derived targets of class 3, as opposed to those of class 2, must truly depend on the different degree of morphophonological complexity. Third and foremost, a multiple regression analysis on the variables RT and Length showed that there was no statistically reliable correlation (0.146; Pr = 0.853). As a consequence, the role played by Length, despite its apparently strong effect in experiment I, should not be considered of primary importance.

4. General discussion.

Three classes of Bulgarian verbs, strictly controlled with respect to frequency, were examined in the two experiments reported on in this paper. In experiment I, class 1 appeared to have a marginally significant advantage over class 2, while in experiment II no such advantage was observed between class 2 and class 3. On the other hand, derived targets of class 3, as opposed to their counterparts in classes 1 and 2, exhibited a rather significant disadvantage with respect to both identity and (most importantly) inflected targets. These findings point towards the tendential relevance of the variable 'morphophonological complexity'. As a matter of fact, derived forms of class 3 (i.e. imperfective verbs derived from perfective ones) were obtained by means of a variety of morphophonological processes, in contrast to the unique and regular process applied in classes 1 and 2. In particular, all derived forms in class 3 exhibited a stress shift (from the last syllable to the penult) that was not to be observed in classes 1 and 2. Note, in this connection, that stress location *per se* did not affect the results, because we did not find any statistically reliable difference (according to the *t*-test) between the identity primes of classes 2 and 3, despite the fact that they were stressed on the penult and on the last syllable, respectively. Incidentally, this also strengthens the conclusion that the variable 'Length', as measured in terms of the mean number of graphemes\phonemes, does not have a decisive effect, considering that class 3 identity primes were more than one grapheme\phoneme shorter than the corresponding items of class 2.

As to the marginal difference between classes 1 and 2, observed in experiment I, the most probable explanation - considering the very limited impact of the Length factor, as observed in sect. 3.4 - is that it depended on the different degree of morphological compositionality of perfective verbs in the two classes. As noted in section 2.4, the presence of the \n\ infix in the perfective verbs of class 2 may induce an extra expenditure of processing time. It should be observed that the \n\ infix, as the distinctive feature of a non negligible set of Bulgarian perfectives, appears to be a well defined and clearly identifiable property, attached to a fairly transparent semantic interpretation (Radanova-Kuševa 1995). From this point of view, identity primes of class 2 appear to differ from the corresponding items of class 1, in the sense that they tend to be perceived as morphologically complex. On the other hand, if we consider that the derivational process involved in imperfectives of classes 1 and 2 appears to be very regular and productive (in so far as it involves the easily identifiable infix /v/), it is no wonder that it did not yield a significant disadvantage for derived targets as compared with inflected ones. Frequent and productive derivational morphemes are obvious candidates for fast processing, on a par with regular (and by definition productive) inflectional morphemes.

By contrast, non-productive and irregular processes, such as those employed in derived targets of class 3, most naturally induce a disadvantage, unless the degree of irregularity is such as to make it desirable for the speaker to store the irregular allomorphs as such. But note that in the case of Bulgarian verbal morphology this would not necessarily produce a real benefit, for the number of forms to be stored would be quite remarkable, considering all the tense, person, number and gender endings that intervene in the conjugation. On the other hand, in noun morphology we do observe situations where direct access might be really advantageous, as noted in Bertinetto & Jetchev (1996; 2000). This was in particular found with respect to morphophonological complexities such as the one that is at work in the class of nouns to which *petél* / *petlí* ('cock' / 'cocks') belongs, consisting in forming the plural by deleting the stressed vowel of the singular form. In this case, the citation form (the singular) did not turn out to yield faster RTs than the inflected one (the plural), in sharp contrast to what happened in the perfectly regular class to which *modél* / *modéli* ('model' / 'models') belongs.

One possible objection is that no contrast was found between identity primes of classes 2 and 3. Indeed, while identity primes of class 2 showed some degree of morphological compositionality (due to the /n/ infix), there is no reason to consider the corresponding items of class 3 as morphologically complex. The most convincing explanation that we can put forward is that, presumably, the RTs of class 3 identity primes were somewhat slowed down by the paradigmatic relation that ties them to their highly irregular imperfective cognates. This is not at all implausible, for Slavic verbs do come in pairs (or even, not infrequently, in triples), which native speakers must be perfectly well aware of. Thus, it is not unreasonable that a paradigmatic effect of this sort was at work in the case of class 3.

In conclusion, although we did not replicate Feldman's (1994) findings concerning the morphological contrast inflection vs. derivation in the lexicon of Slavic languages, we found initial evidence of the possible interaction between morphological and morphophonological complexity in one class of Bulgarian verbs. Among the questions that remain to be answered by future research, we would like to single out the following two. First, it is possible that the limited impact of the contrast inflection vs. derivation in our materials was due to the non-prototypical nature of derivational processes in Slavic aspectual pairs. Second, it is also possible that the use of different targets (closer to the default form of Bulgarian verbs) might increase the priming effect. Finally, it is not unlikely that other experimental techniques (such as immediate priming, with the appropriate Stimulus Onset Asynchrony) yield the expected contrast between inflected and derived items. We are planning further investigations in this direction.

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Appendix I

Materials used in experiment I and II, with average subjective frequency ratings for each verb and subclass. The forms listed are those of the 2nd sg. Future.

Class 1 (overall = 2.23) perfective (overall = 2.26)	imperfective (overall = 2.28)
frequent (overall = 2.61)	frequent (overall = 2.58)
uplas&'frighten' (3.07)	uplas&am (2.93)
podkupja 'bribe' (2.35)	podkupvam (2.67)
zasramja 'make feel ashamed' (2.53)	zasramvam (2.4)
obelja 'peel' (2.6)	obelvam (2.6)
zapus&'clog, plug' (2.67)	zapus&am (2.4)
om z&'marry ' (2.47)	om z&vam (2.47)
rare (overall = 1.91)	rare (overall = 1.99)
progonja 'chase away' (1.8)	progonvam (2.0)
zahlupja 'cover' (1.73)	zahlupvam (1.93)
zag rbja 'turn one's back to/on' (2.33)	zag rbvam (2.2)
izplezja 'stick out one's tongue' (1.73)	izplezvam (1.93)
obesja 'hang' (1.8)	obesvam (1.87)
izkopc&'scrounge' (2.07)	izkopc&am (2.0)

Class 2 (overall = 2.27) perfective (overall = 2.23)	imperfective (overall = 2.24)
frequent (overall = 2.51)	frequent (overall = 2.55)
prek sna 'interrupt' (3.07)	prek svam (3.07)
nastina 'catch cold' (2.33)	nastivam (2.64)
izp kna 'stand out' (2.6)	izp kvam (2.47)
otbl sna 'repel' (2.53)	otbl svam (2.47)
otkrehna 'open a little' (2.2)	otkrehvam (2.4)
izplakna 'rinse' (2.33)	izplakvam (2.27)
rare (overall = 1.94)	rare (overall = 1.93)
og«na 'bend' (2.07)	og vam (1.93)
zapretna 'tuck up' (2.13)	zapretvam (1.8)
zaml kna 'become silent' (1.8)	zaml kvam (2.0)
iztr gna 'wrench' (1.87)	iztr gvam (2.0)
zagl hna 'dim' (1.79)	zagl hvam (1.93)
omekna 'become soft' (2.0)	omekvam (1.93)

Class 3 (overall = 2.35)	perfective (overall = 2.44)	imperfective (overall = 2.35)
nabera 'pick up' (3.0)		nabiram (3.4)
izčeta 'read up' (2.65)		izčitam (3.05)
premeta 'sweep out' (1.85)		premitam (1.75)
potresa 'upset' (1.95)		potrisam (1.85)
zapleta 'interweave' (1.95)		zaplitam (2.3)
izdera 'scratch' (1.9)		izdiram (1.6)
v znesa 'exalt' (1.55)		v znasjam (1.8)
izboda 'sting, prod' (1.6)		izboždam (1.75)
naveda 'bend' (3.25)		naveždam (3.5)
dojam 'eat up' (2.8)		dojaždam (2.95)
provra 'thread' (2.0)		proviram (2.35)
podprpa 'shore up' (2.6)		podpiram (3.0)