STUDIES IN LANGUAGE AND MIND

Edited by Sabina Halupka-Rešetar and Silvia Martínez-Ferreiro

Novi Sad, 2016

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SELECTED PAPERS FROM THE 3RD WORKSHOP IN
PSYCHOLINGUISTIC, NEUROLINGUISTIC
AND CLINICAL LINGUISTIC RESEARCH

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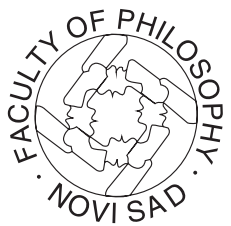

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PREFACE

This publication is a selection of papers presented at the 3rd workshop in *Psycholinguistic, neurolinguistic and clinical linguistic research*, which was held at the University of Novi Sad on April 18th 2015. During this one-day event, researchers from five countries and six university centres presented their work with the aim of encouraging an interdisciplinary approach to researching the neurocognitive foundation of language in linguistically non-impaired and impaired populations.

The volume contains six chapters. Each of the papers submitted to the volume received two blind reviews and in some cases additional comments from the editors. The papers in the volume are organized thematically, starting with a general overview of research in the field of clinical linguistics research conducted with speakers of Bosnian, Croatian, Montenegrin and Serbian (BCMS or Serbo-Croatian).This introductory chapter, co-authored by Silvia Martínez-Ferreiro, Sabina Halupka-Rešetar and Alexandra Perović summarizes studies of genetic, developmental and acquired disorders conducted with subjects who are native speakers of one of these South Slavic languages, including Down syndrome, Specific Language Impairment and aphasia. As studies of language deficits in the four languages mentioned are still rather scarce, the paper concludes with a brief discussion and a set of suggestions for future research in the field of clinical linguistics.

The following five chapters present recent empirical findings in BCMS, conducted with non-brain damaged individuals and children. In Chapter 2, 'Effect of animacy and agentivity on the processing of agreement in Serbo-Croatian', Boban Arsenijević and Ivana Mitić reported on two experiments, one involving acceptability judgments and the other production, focused on the effects of animacy and agentivity, respectively, on the choice of the pattern of agreement of the verb with a coordinated subject in Serbo-Croatian (given that Serbo-Croatian coordinated subjects with mixed gender values allow for three patterns of agreement: agreement with the first member of coordination, agreement with the last member, and agreement

with the entire coordination). The experimental results lead the authors to the conclusion that animacy has a general degrading effect on coordinated subjects, which is very strong in agreement patterns involving agreement with the closest member of coordination, and weaker in expressions involving agreement with the highest member of coordination and default agreement. Only agreement with the member of coordination which is both lowest and farthest away from the subject was in no way affected. Agentivity seems to show a somewhat different effect, as it decreases the number of produced instances of agreement with the linearly closest member of coordination, but increases the number of produced expressions involving agreement with the highest member of coordination, with no significant effect on other patterns of agreement. Arsenijević and Mitić take these results as evidence in support of the family of approaches in which agreement with the linearly closest member of coordination is one of the available strategies, and in which it takes place at the interface between syntax and phonology. Default agreement is shown to involve features which are present already in syntax, but they do not compete with phonological agreement.

In 'Distributivity and Agreement mismatches in Serbian', Ana Bosnić presents the results of a truth value judgment study done on two types of numerals in the Serbian numerical system, namely paucal and mixed-gender, and the corresponding verbal agreement mismatch that is characteristic for the numerals in question. Although recent work on agreement and distributivity suggests that singular verbal marking promotes distributivity while plural marking can be interpreted as both distributive and collective, Serbian informants have shown opposite intuitions – singular appeared to suggest collectivity and plural marking denoted distributivity. Given the highly inflectional nature of the Serbian language, the chapter authored by Bosnić investigates the extent to which verbal agreement influences interpretation preferences. The two types of numerals were used with singular and plural verbal agreement on two groups of participants, adults and 7-year-old children. Neither group showed a significant correlation between verbal agreement and collective/distributive interpretations. Adults accepted collective readings and dispreferred distributive ones, while children accepted both distributive and collective readings for all sentence forms, even at their early age. This is taken to suggest that morpho-syntactic inflections might not be strong markers for distributivity and collectivity, contrary to what

has been proposed in the literature, and it leads the author to propose an alternative explanation in which adults understand numerically quantified sentences without distributive markers as scalar implicatures – since there is a better alternative to convey a distributive message, numerically quantified sentences must be collective. On the other hand, the complex morpho-syntactic system of Serbian seems to load children's working memory, which affects the processing of such ambiguous sentences.

In Chapter 4, 'Verb production at different stages of language acquisition', Nina Ilić aims to contribute to the ongoing debate between nativists and constructivists by examining the order in which different types of verbs with different argument structure are acquired (unergative, unaccusative, anti-causative, transitive and ditransitive verbs). Twelve subjects (1;11 - 4;10 years old) classified into age groups participated in the structured interviews of this transversal study. Children were asked to name actions based on visual stimuli such as toys and drawings. Though the sample was small, across-group differences were noted. The results confirm that children who are at an earlier stage of speech development have more difficulty producing verbs with a complex argument structure and are most successful in producing verbs which show a subject-agent correspondence. However, anti-causatives, which are also one-place predicates, are produced at a much later stage (2;7 years in this research). The results show that the order of acquisition of verbs is the following: transitive, unergative, unaccusative, ditransitive and anti-causative verbs. The author also stresses that the participants in the study used adequate tense morphology on the verbs from the earliest age, which is taken to indicate that they can recognize verbs as members of a coherent syntactic category, different from that of nouns. Thus, the results obtained are taken to favour the nativist approach.

Chapter 5, co-authored by Dušica Filipović Đurđević, Jelena Karapandžić and Jasmina Arsenijević Mijalković and entitled 'Presentation modality interacts with the effect of visual perceptual strength on word processing' investigates the effect of visual perceptual strength across abstract and concrete words, as well as its relation with the modality in which a word is presented. Relying on Perceptual Symbol Theory and previous findings, the authors hypothesized that visual perceptual strength would negatively correlate with processing cost and that it would have a stronger effect when the presentation modality coincides with the modality by which the concept

denoted by a word is experienced. These predictions were tested on abstract and concrete nouns which can only be perceived visually. In both word groups the level of visual perceptual strength varied on a continuous scale. All groups of words were presented in both a visual and auditory lexical decision task. The results revealed no main effect of visual perceptual strength and an interaction between visual perceptual strength and presentation modality. This interaction revealed that the effect of visual perceptual strength was present only in visual lexical decision task, as expected. However, the direction of the effect was opposite to the one predicted. Additional analyses located this effect only in the case of concrete words. While the observed results can only partly be interpreted by Perceptual Symbol Theory, they contradict predictions of amodal theories.

The last chapter of the volume, 'A quest for sources of perceptual richness: Several candidates' by Dušica Filipović Đurđević, Milica Popović Stijačić and Jelena Karapandžić presents the results of a norming study and a lexical decision experiment with 200 Serbian nouns, which were rated for general concreteness and for modality-specific concreteness. The study is novel in that it presents modality-specific concreteness ratings which were obtained separately for the possibility to experience and the actual sensory experience. Based on modality-specific ratings, several integrative measures of concreteness were derived. The authors explored relations among the collected measures and tested for their predictive power regarding general concreteness rating and processing time. In addition to demonstrating the overall relatedness of various measures of concreteness, the results obtained in this study suggest the advantage of modality-specific concreteness measure over and above that of concreteness as traditionally operationalized. This is in accordance with some previous research and supports Embodied Cognition accounts. However, the authors note that the very measures that were the best predictors of concreteness and reaction time in this particular study are not the measures that were the best predictors in previous research, which points to the need for more comprehensive studies or larger datasets.

The organizing of the workshop and the publication of this volume, which grew out of it, would not have been possible without the generous support of the Dean's Office of the Faculty of Philosophy. We are grateful to the reviewers of this volume for their time and thoughtful comments. We

offer our thanks to all those who helped make the workshop the success it was – Professor Vladislava Gordić Petković, Head of the English Department, the Editorial Board and the Organizing Committee. Last but not least, we would like to thank all contributors for inspiring progress in the field through their work on a wide range of topics.

The Editors,
Novi Sad, April 2016

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CLINICAL LINGUISTICS IN BOSNIAN / CROATIAN / MONTENEGRIN / SERBIAN (BCMS): DOWN SYNDROME, SPECIFIC LANGUAGE IMPAIRMENT AND APHASIA[1]

Abstract: The aim of this paper is to give an overview of research in the field of clinical linguistics focusing on several closely related South Slavic languages, namely Bosnian, Croatian, Montenegrin and Serbian (BCMS or Serbo-Croatian). It summarizes studies of genetic, developmental and acquired disorders conducted with participants who are native speakers of one of these languages, including Down syndrome, Specific Language Impairment and aphasia. As studies of language deficits in these four languages are still rather scarce, the paper concludes with a brief discussion and a set of suggestions for future research in the field of clinical linguistics.

Key words: language impairments, clinical linguistics, Down syndrome, Specific Language Impairment, aphasia.

Clinical linguistics is a relatively new discipline, emerging in large part since the late 1970s, which can be defined as "the application of the linguistic sciences to the study of language disability in all its forms" (Crystal, 2001:673). The creation of multidisciplinary research teams for the inves-

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tigation of language in the past decades has had a direct impact on the field of language pathologies, significantly increasing the number of proposals available in the literature. Studies aimed at investigating clinical populations are a valuable source for the generation and improvement of assessment and treatment methods, but are also crucial to establishing the validity of theoretical linguistic proposals addressing the underlying mechanisms of language processing (Ball & Kent, 1987; Perkins & Howard, 1995). However, there is a striking imbalance in the number of studies carried out in different languages, as well as in the pathologies addressed in these studies. While the bias towards English is clear, studies in BCMS remain scarce. In the following pages, and as a follow up of previous efforts targeting verb deficits in aphasia (Martínez-Ferreiro & Halupka-Rešetar, 2014), we aim at creating a state of the art review, gathering the already existing studies, and locating them in the frame of cross-linguistic literature. Additionally, given the interest of scholars and students at the *3rd workshop in Psycholinguistic, neurolinguistic and clinical linguistic research*, held at the Faculty of Philosophy, University of Novi Sad on April 18th, 2015, we aim at pinpointing specific topics of relevance to be considered for future research. To fulfil this aim, we have selected a number of studies using the following inclusion criteria: published papers and theses (vs. abstracts and unpublished manuscripts) written in English (with the exception of diagnostic batteries). These papers are devoted to the exploration of three main pathologies with very diverse aetiologies: aphasia, Specific Language Impairment (henceforth SLI), and Down syndrome (DS).

The structure of this review is as follows. After a brief introduction to the disorders addressed in the paper (Section 1), we discuss genetic and developmental disorders (SLI and Down syndrome) in BCMS (Section 2). The topic of acquired disorders (aphasia) in BCMS is tackled in Section 3. The article concludes with a brief discussion and a set of suggestions for future research (Section 4). Although we aim at characterizing Bosnian / Croatian / Montenegrin / Serbian (BCMS) altogether, in order to preserve geographical information, we keep the labels as included in the original sources of reference. Consequently, different terms coexist along these lines (e.g. Serbian, Croatian, Serbo-Croatian, and Yugoslav speakers).

1. Language disorders addressed in the paper

The first description of a clinical case in the BCMS literature can be found in Dimitrijević (1940/1983; *apud* Fabbro, 1999), who described the case of a multilingual late acquirer of Serbian diagnosed with aphasia after vascular insult. However, despite this early interest, the number of studies targeting language deficits in South Western Slavic languages remains scarce. In what follows, we give a brief description of SLI, Down syndrome and aphasia, the three disorders which are the focus of attention in the next sections.

Despite controversies surrounding the accurate definition and accounts of SLI (see Leonard, 2014, for a review of linguistic and processing accounts of the disorder), this label is still used to describe a heterogeneous developmental disorder characterized by a significant discrepancy between language and non-verbal cognitive performance, in absence of other developmental disorders, auditory loss or acquired brain damage. Hence, the diagnosis of SLI is mainly established by exclusion (Leonard, 2014), and nowadays tends to be taken as a description of a phenotype and probably has multiple biological causes, including genetic factors.

Most typical characteristics of SLI include inconsistent skills across different language domains affecting both production and comprehension that persist over time. In addition to pervasive morphosyntactic deficits, SLI involves problems with the selection and combination of sounds, impoverished vocabulary – including word finding, repetition deficits and deficits in discourse. However, there is variability as for the prevalence of these alterations (Bishop, North & Donlan, 1996; Cohen, 2002; Conti-Ramsden & Hesketh, 2003; Novogrodsky, 2015; among many others). Some attempts have been made to classify different types of SLI (Rapin & Allen, 1983; Friedmann & Novogrodsky, 2008), including lexical (LeSLI), phonological (PhoSLI), pragmatic (PraSLI), and syntactic (SySLI) SLI, mainly affecting naming, repetition of non-words, narrative tasks, and syntactic structures, respectively (Friedmann & Novogrodsky, 2008), while comorbidity with dyslexia is widely reported (Bishop & Snowling, 2004).

Linguistic literature on SLI has been primarily concerned with deficits in grammatical morphology, with omissions of tense and/or agreement argued to be the main characteristic of SLI in English and other Germanic languages (e.g. Rice & Wexler, 1996) and omission of object clitics in

Romance (e.g. Jakubowicz, Nash, Rigaut & Gérard, 1998; Gavarró, 2012; Arosio, Branchini, Barbieri & Guasti, 2014). Deficits in complex syntactic dependencies are also reported, especially with the production and comprehension of wh-questions, relative clauses and passives, in all languages studied: English, Italian, French, Greek and Hebrew, among others (e.g. van der Lely & Battell, 2003; van der Lely, 1996; Riches, Loucas, Charman, Simonoff & Baird, 2010; Adani, Guasti, Forgiarini & van der Lely, 2014; Stavrakaki, 2001; Friedmann & Novogrodsky, 2004). Early studies have also reported impairments in reflexive and pronominal binding (van der Lely & Stollwerck, 1997), though more recent studies of English and Hebrew SLI argue for an intact comprehension of binding in this population (Novogrodsky & Friedmann, 2010; Perovic & Wexler, to appear).

Another developmental disorder to be addressed in the context of BCMS is Down syndrome (henceforth DS). DS is a genetic disorder caused by an error in cell division generating the emergence of three copies of chromosome 21 instead of the usual two (trisomy 21). It is one of the most common conditions involving a learning disability, affecting 1 in 700-1000 babies of both genders. For typical trisomy, IQ is in the moderately to severely impaired range, though wide individual variation has been reported in all aspects of cognitive functioning. Delays of speech and language development are common, however, a strikingly poor linguistic achievement is one of the characteristics of this condition that sets it apart from other genetic disorders (Rondal, 1988; Miller, 1988). Speech intelligibility is reduced by both mechanical problems and inappropriate phonological processes (Dodd, 1976), though concrete vocabulary and word recognition skills tend to be in line general cognitive abilities (Abbeduto, Warren & Conners, 2007). Grammatical morphology seems most affected, with the omission and inconsistent use of both free function words (copulas, auxiliaries, modals, articles, prepositions, pronouns, conjunctions, and infinitive 'to') and bound grammatical morphemes (plural –s, possessive –s, third person singular, contractible auxiliaries and copulas, regular past tense –ed) resulting in short telegraphic utterances in most individuals with DS (Fowler, 1990; Chapman et al.1998). Studies show that complex syntactic structures such as auxiliary inversion, subordinate clauses, relative clauses and passives are rarely mastered by either children or adults with DS (Fowler, 1990; Bridges & Smith, 1984; Rondal & Comblain, 1996), while deficits in

binding have been uncovered in different languages in recent years: English (Perovic, 2004; Ring & Clahsen, 2005); Greek (Sanoudaki & Varlokosta, 2014) and Serbian, as we will see in ensuing sections (Perovic, 2004; 2008).

Leaving developmental disorders behind, aphasia is an acquired language disorder that has been traditionally characterized as the lack of communication by means of words (Trousseau, 1864), including both their spoken and written version. It is due to focal brain injury, i.e. it emerges as a consequence of a lesion to the parts of the brain responsible for language. When damage is located in the left hemisphere, it affects most right-handed people and over 50% of left-handed people. The aetiology of this deficit is diverse, and it may follow from cerebro-vascular accidents (of ischemic and haemorrhagic origin), intracranial haemorrhages, wounds and contusions, tumours, brain insults and degenerative deficits such as dementia (Goodglass & Kaplan 1972, 1983; Grodzinsky, 1990; American Speech-Language-Hearing Association, 2016).

According to the Boston classification system (Goodglass & Kaplan 1972, 1983), the term aphasia is an umbrella term that gathers together eight main syndromes (note also the existence of childhood aphasia and primary progressive aphasia, the latter being a consequence of a degenerative process). Fluency is the key to establishing the classification, although comprehension, repetition, and naming skills are also taken into consideration. Among the non-fluent deficits, characterized by displaying impaired production and better preserved comprehension, we find motor (Broca's) aphasia, transcortical motor aphasia, global aphasia, and transcortical mixed aphasias. The fluent deficits include sensory (Wernicke's) aphasia, transcortical sensory aphasia, conduction aphasia, and anomic aphasias.

Consequently, individuals with aphasia may experience problems with any or all of the following skills: production, comprehension, reading, writing and gesturing. Variability across individuals may be observed through recovery patterns. Although on average 25% of patients recover in 3 months, 25% of individuals with aphasia are still severely affected after 6 months (Goodglass & Kaplan, 1972). Severity tends to be related to amount and location of brain damage (Grodzinsky, 1990). Recovery patterns vary in different modalities (production vs. comprehension), and different languages (L1/L2/Ln). Individuals with aphasia may also suffer from related problems such as motor problems, including dysarthria, apraxia, or swallowing disorders.

The scarcity of data available for South Western Slavic languages is reflected not only in linguistic studies per se, but also in everyday clinical practice. An example can be found in the realm of diagnostic tools. While in the case of developmental pathologies there are a number of tests produced for the assessment of deficits in BCMS (Vladisavljević, Kostić & Popović, 1983; Vasić, 1991; Vladisavljević, 1997; Kovačević, Jelaska, Kuvač & Cepanec, 2005; Kovačević, Padovan, Hržica, Kuvač, Mustapić, Dobravac & Palmović, 2010), with the exception of Vasić's (1991) and Kovačević et al.'s (2010) work which includes tests for both infants and adults, no specific tests for diagnosing impairments in adults have been created so far, and those available are, at best, still at different stages of standardization (Smith & Mimica, 1984; Vukovic, Vukovic & Stojanovik, 2010; Vukovic & Stojanovik, 2010).

Vladisavljević, Kostić and Popović's (1983) and Vladisavljević's (1997) works have been used for the diagnosis of SLI and include assessment of spontaneous speech, gathered by means of a story generation task with pictures, and an articulation test, which includes naming and repetition tasks also with picture support (similar to Vasić, 1991). Spontaneous speech samples are analysed relying on measurements of the total number of words, total number of sentences and clauses (to the inclusion of grammatical and ungrammatical sequences), and number of ungrammatical clauses. The articulation test controls for the ability to correctly produce all the sounds of Serbian.

Kovačević et al. (2005) have developed the Croatian version of the *Communicative Development Inventories* (CDIs) (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick & Reilly, 1993), the parent report instruments for assessing the language development of infants (8-16 months of age) and toddlers (16-30 months), including vocabulary comprehension, production, gesture use and early grammar. The instrument is also appropriate for the assessment of late language development. Finally, Kovačević et al. (2010) have adapted the *Peabody Picture Vocabulary Test* to Croatian. This test, originally designed by Dunn (1959), assesses receptive vocabulary based on a series of pictures and allows a quick insight into the verbal abilities of infants, although recent versions can also be used in adult populations.

In the realm of aphasia, although verbal and nonverbal cognitive tests are regularly used for diagnosis in BCMS, the specifics of these batteries are

not always clear. As an example, Smith and Mimica (1984: 280) mention that "the battery [they use] cover a range of areas comparable to that of the *Boston Diagnostic Aphasia Examination*" (BDAE; Goodglass & Kaplan, 1972, 1983). Although there are Serbian versions of both the BDAE and the *Western Aphasia Battery* (WAB; Kertesz, 1982) (see Lukatela, Shankweiler & Crain (1995) a.o. for the former, and Jovanov (2011) a.o. for the latter), as well as the *Token Test* (DeRenzi & Vignolo, 1962) and the *Boston Naming Test* (Kaplan, Goodglass & Weintraub, 1983), according to Vukovic, Vukovic and Stojanovik (2010), none of the above mentioned language batteries have been standardized for the Serbian population (or to any other South Western Slavic variety). However, all of them are regularly used in clinical practice, as there are no other measurements available.

However, the field is changing fast for the better. A new Serbian version of the *Token Test* has been added to the multilingual i-pad version developed by Bastiaanse, Raaijmakers, Satoer and Visch-Brink (2015). Additionally, the Croatian and Serbian versions of the *Comprehensive Aphasia Test* (CAT; Swinburn, Porter & Howard, 2005) are currently in preparation by Kuvač Kraljević and Kovačević (Croatian) and Vuksanović and Bjekić (Serbian) as part of the ISCH COST Action IS1208 Collaboration of Aphasia Trialists (CATs). In addition to the previously mentioned tests devoted to assessing languages individually, a culturally and linguistically adapted electronic version of the *Bilingual Aphasia Test* (BAT; Paradis & Libben, 1987), designed to assess each of the languages of a bilingual or multilingual individual with aphasia in an equivalent way, is available in Bosnian, Croatian and Serbian (adapted by Bilanović, Pilković and Milojković, respectively. The language pair-specific tests available are Bosnian-Danish, Bosnian-German (adapted by Kapetanović and Müller), Croatian-English, Croatian-French, Croatian-German (adapted by Kapetanović and Müller), Croatian-Italian, Serbian-English and Serbian-German. The materials can be accessed at http://www.mcgill.ca/linguistics/ research/bat/).

2. Developmental language disorders in BCMS

In this section, we summarize the existing data on a set of conditions that affect language from the very first stages of its development, and that,

consequently, have a direct impact on the process of language acquisition. More specifically, we focus on SLI and Down syndrome.

As Palmović (2007: 55-56) reports, investigations of SLI have generally focussed on language production (Kovačević et al. 1997). Three examples from the speech output of Serbian children with SLI are reproduced below. The sentences in (1) show omission of the reflexive clitic *se* and the auxiliary verb in perfect tense (the grammatical sentences are *Bata SE popeo gore* and *Bata JE pao dole*, respectively). The example in (2) illustrates a syntactically unacceptable structure.

(1) a. *Bata popeo gore.
The boy climbed up.
b. *Bata pao dole.
The boy fell on the ground.
(2) *Jednog dana kad bile jabuke
one day when were apples
One day there were apples.
(from Vukovic & Stojanovik, 2011: 191-192)

Ljubesic and Kovacevic (1992) first reported the results of a short-term longitudinal study of 61 Croatian speaking children with SLI, aged 7-10. The study tested the contrast between plural and dual formation and the sensitivity to inflection violations. Dual marking on nouns was found to be more compromised than plural marking. As for the accuracy in the identification of incorrect inflections, rates were lower than in age-matched controls. However, the relatively low number of errors overall lead the authors to conclude that 'there is no evidence of general deficiency in acquired morphological knowledge' (p.41) in the SLI group.

Palmović (2007) conducted six ERP experiments in order to gain insight into language comprehension in Croatian in three groups of participants: adults, children with typical language development (TLD) and children with SLI. Regarding the difference between children with TLD and children with SLI, who were tested on case and tense violations, a weak electrophysiological effect or absence of difference was found between experimental conditions and even between experiments. This suggests that children with SLI at least partly fail to detect grammatical errors and, consequently, achieve sentence comprehension

using alternative strategies. The differences noted can be explained in terms of impaired, inefficient, limited or slow processing in SLI children, which is a consequence of slower development rather than lack of linguistic knowledge.

In a recent study, Vukovic, Vukovic and Stojanovik (2010) investigated language and motor abilities in 30 Serbian speaking children with SLI aged 4-7. Language skills were tested by means of a story generation task (Kostic & Vladisavljevic, 1983), the *Token Test* (DeRenzi & Vignolo, 1962), the *Boston naming Test* (Kaplan, Goodglass, &Weintraub, 1983), and a test of articulation (Kostic & Vladisavljevic, 1983). Motor skills were tested using *McCarthy's Scales of Children's Abilties* (McCarthy, 1972) and the test of imitation of movements (Berges & Lezine, 1972). Results indicated that children with SLI had significantly more difficulties on the language assessments compared to controls, but they also displayed a delayed onset in the development of all motor skills under investigation. Differences between children with SLI and controls also emerged with respect to the language abilities, which were shown to correlate with motor abilities. The results show no significant differences as for the mean number of words produced in picture description or the total number of clauses. However, significant differences appear in the total number of ungrammatical clauses as well as in the Boston Naming Test, the Token test, and the mean number of incorrectly produced sounds. In addition, children with SLI were found to have accompanying motor deficits. Motor skills involving imitation of complex movements were found to be a significant predictor of expressive vocabulary in individuals with SLI. The emergence of language deficits together with motor deficits coincides with cross-linguistic results, raising the question of how "language specific" SLI is (Bishop, 1994; Leonard, 2014).

Vukovic and Stojanovik (2011) focused on the use of auxiliaries and clitics as well as the production of ungrammatical constructions during a story telling task with picture support in 30 Serbian speaking children with SLI. The results showed significant asymmetries across populations regarding the number of words (14.9 on average in the SLI group vs. 19.4 in the age-matched group), together with a pervasive omission of both auxiliaries and clitics (0.67 on average in the SLI group vs. 0.034 in the control group for auxiliaries, and 0.47 vs. 0 for clitics). As for the presence of deviant constructions, differences across groups also reached significance with no errors detected in the control group (vs. 0.17 in the SLI group). Children with SLI

also performed worse than controls on the Token Test (DeRenzi & Vignolo, 1962) and the Boston Naming Test (Kaplan, Goodglass & Weintraub, 1983).

Perovic & Vuksanovic (2012) investigated comprehension of verbal passive in Serbian speaking children with SLI, a complex syntactic structure whose production and comprehension has been reported to present particular difficulty for English-speaking children with SLI. Twenty-eight children with SLI and an equal number of their non-verbal MA-matched controls, aged between 3;04 and 8;08, were tested on a two picture selection task, involving passives of actional (e.g. *push*) and non-actional verbs (e.g. *love*), with and without the by-phrase (i.e. 'long' and 'short' passive). Children with SLI performed no differently to matched control children on control (active SVO) sentences which included either actional or non-actional verbs, and no different on short passives of actional verbs. Though both groups found the comprehension of non-actional passives difficult, this was particularly pronounced for children with SLI, who also performed worse on actional long passives. In line with the literature on English SLI, these data suggest that the process of the acquisition of passives in Serbian SLI closely follows that of typical development, but is significantly delayed.

Compared to SLI, studies of language abilities in other developmental disorders are exceptionally rare in BCMS. In a study on grammatical morphology in Serbian Down syndrome, Perovic (2010) analysed spontaneous speech and narratives elicited by the wordless picture book *'Frog where are you?'* (Mayer, 1969) of six adolescents and young adults with this disorder. The language samples revealed relatively spared morphosyntax in all the participants, though striking difficulties were observed in the use of nominal inflection, as observed in the incongruous gender on nouns and determiners (see examples below).

(3) ovaj kuče
this-sg-**Masc** puppy-sg-**Neut**
this puppy

(4) neki rupu
some-sg-**Masc** hole-sg-**Fem**
some hole

Other errors involved difficulties marking subject-verb agreement, i.e. mismatch in number or gender between the subject and the verb, as well

as occasional incorrect case on sentential subjects or objects, incorrect case within a PP, as well as preposition omission.

The same participants were tested on their knowledge of binding in Perovic (2004, 2008) where their performance was contrasted to that of English-speaking individuals with DS and non-verbal mental age (MA)-matched typical controls. The task was a picture truth value judgment task, adapted from Chien & Wexler (1990), which elicited yes-no answers to questions matching or mismatching the picture shown. Eight experimental conditions contained sentences aimed to test participants' interpretation of third person singular pronouns in both their strong form (*njega, nj*u) and clitic form (*ga, je*), as well as the strong reflexive form (*sebe*) and the reflexive clitic (*se*). Four control conditions involved sentences without any pronominal elements, in order to test participants' attention and general understanding of the task. Good performance was attested in control conditions and experimental match conditions (note that match conditions are considered easier as participants are required to answer 'yes' to questions posed). As for the mismatch condition, accuracy rates for pronouns reached 91%, while reflexives were correctly interpreted only 63.5% of the time. Embedded within the theoretical approach to binding of Reinhart and Reuland (1993), the pattern of good performance on the reflexive clitic (considered a marker of inherent reflexivity) was explained as evidence that participants know the semantic properties of reflexive predicates (i.e. possess the knowledge of conditions on reflexivity as in Reinhart & Reuland, 1993), but their poor performance on the full reflexive, parallel to that observed in English speaking individuals with DS, reveals an inability to establish a syntactic relationship of binding between the reflexive and its antecedent. The overall pattern is taken as evidence against the characterisation of language development in DS as simply delayed, since the pattern of better performance on pronouns and poorer performance on reflexives has not been observed during any stage of typical language development (see Perovic, 2016).

3. Acquired disorders in BCMS

The label "acquired language disorders" is generally used to refer to a set of pathologies that appear abruptly once the course of language ac-

quisition has finished. Acquired disorders, and more specifically aphasia, are amongst the most widely investigated deficits in BCMS, as evidenced by the publication in 2010 of the 2nd edition of the manual *Afaziologija* by Vukovic, written in Serbian. This bias is more evident when it comes to the characterization of verbs, the category accumulating more attention. An example of the spontaneous speech of an individual with a non-fluent aphasia is reproduced below:

(5) Pa... mama briše tanjir.
Well... mama is drying the plate.
De... dečko... kolači... devojčica uzmi uz..uzima...
The b..boy... cookies... the girl take ta.. is talking...
Voda curi.
The water is leaking.
(*Cookie theft description* – BDAE: Goodglass & Kaplan 1972, 1983 – from Lukatela, Crain & Shankweiler, 1988: 193)

The first documented case of an acquired aphasia is in fact a description of childhood aphasia in a bilingual child (Bouquet, Paci & Tuvo, 1981). Bouquet, Paci and Tuvo (1981) describe a patient aged 4;4 who was already fully bilingual (Italian-Croatian) at the time he suffered severe cranial trauma. Although the child started uttering words in Italian a month after the trauma, his inventory of Croatian was reduced to only two words (*nos* 'nose' and *trešnje* 'cherries'). Six months after the trauma, he was found to have recovered Italian completely. The only residual sign of aphasia was a mild uncertainty in using Croatian (Fabbro 1999: 175).

Leaving childhood aphasia behind, the first general description of preserved vs. damaged categories in the speech output of adult individuals with non-fluent aphasic deficits in Serbo-Croatian traces back to Zei and Šikić's (1990) analysis of narratives in two Croatian participants with Broca's aphasia as a consequence of an aneurysm and a trauma. The authors document a low number of occurrences of verbs and adverbs (15.9% and 3.8% of the correctly supplied forms, respectively), in addition to the simplification of consonantal clusters and phoneme substitutions. In contrast, there is an overuse of nouns (42.8% of all the words correctly supplied by S01) and nominative case (63% of inflected forms used by S01), infini-

tives and verbal forms in present tense. The occurrence of other forms such as adjectives, demonstratives, possessives, personal and relative pronouns, prepositions and subordinate conjunctions was also found to be reduced.

Focusing on inflectional morphology in non-fluent aphasias, Lukatela, Crain and Shankweiler (1988) provided a more exhaustive analysis of six Serbo-Croatian-speaking individuals with agrammatism of different aetiological origin. Based on a grammaticality judgement test, the authors reported the subjects' preserved sensitivity to the subcategorization requirements of transitive and intransitive verbs and closed-class morphology, with results uncontroversially above chance level. In the grammatical condition, the group supplied 94.5% and 91.3% correct answers for transitive and intransitive verbs, respectively. The number of errors was shown to increase slightly in the ungrammatical condition, with 89.5% correct for transitive and 86.3% correct for intransitive verbs. A consistent favouring effect was found towards transitive forms. These results replicated those in Smith and Mimica's (1984) study of ten Yugoslav individuals with agrammatism in the comprehension of agent-object relations in sentences with two nouns and a transitive action verb.

Smith and Mimica (1984) also report that thematic-role assignment may be impaired due to the patients' inability to use case information, in addition to their poor use of positional information. In a study on comprehension of simple declarative sentences, individuals with Broca's aphasia assigned the Agent role to the first noun in 68% of the nominative-accusative items, and in 46% of the accusative-nominative items. Since the use of semantic animacy information is unimpaired in this population, that is since individuals with agrammatism still make use of the contrast animate-inanimate to determine the role of a noun, this may have a favouring effect in correct thematic-role assignment.

Couching their findings within Grodzinsky's (1984, 1986, 1990) proposal that the cause of comprehension deficit in agrammatism is due to partial loss of syntactic knowledge, Milekić, Bošković, Crain and Shankweiler (1994) investigated the sensitivity to traces and the knowledge of the inflectional and determiner system in a group of eight native speakers of Serbo-Croatian with Broca's aphasia with agrammatism, performing a grammaticality judgement task. The findings of this study are in accordance with previous studies: grammatical constructions were easier to identify than

grammatical violations, although both conditions were completed above chance (95.2% vs. 85.4% correct, respectively). These results go against the general claim that the content of functional elements is lost in agrammatism, and point towards less restrictive proposals such as those based on processing demands (Caplan, 2006). However, despite high accuracy rates, different tendencies across constructions have been documented in the ungrammatical condition. Ungrammatical sentences involving a non-nominative subject (6a) and violations of SV agreement (6b) were detected in 81.25% of the cases, while vacuous quantification (7) and violations related to (agreement mediated with) NP-traces (8) were more difficult to perceive (with 73.75% and 72.5% correct answers, respectively). This indicates that agreement features and tense specification may prevail in comprehension, together with sensitivity to case violations with nouns and determiners and the capacity of binding a wh-phrase with a variable (a wh-trace).

(6) a. *Mušteriju je udarila prodavačicu.
customer-Acc hit saleswoman-Acc
b. *Direktor kažnjavaju učenike.
principal-3sg punish-3plPres pupils
(7) a. *Ko doktor leči pacijenta?
who-Nom doctor is treating patient-Acc
b. Koga$_i$ doktor leči t$_i$?
who-Acc doctor-Nom is treating
(8) *Komšija$_i$ moraju t$_i$ biti dobri.
neighbour-3psg must-3pl be good-3pl

In a related study, Lukatela, Schankweiler and Crain (1995) tested the comprehension of Serbo-Croatian speaking agrammatic aphasics on four types of relative clause structures and on conjoined clauses. The relative clauses varied in type of embedding (embedded vs. non-embedded) and in the location of the gap (subject position vs. object position). There were two control groups, subjects with Wernicke-type aphasia and non-brain damaged subjects. The findings from a sentence-picture matching task indicated that individuals with agrammatic aphasia were able to process complex syntactic structures, as evidenced by their well above-chance performances. The success rate varied across different types of relative clauses, with

object-gap relatives yielding more errors than subject-gap relatives in all groups. The error pattern was the same in all three groups, the subjects with agrammatism being distinguished from the other two groups only in the quantity of errors. Again, Lukatela et al. (1995) claim that these findings are incompatible with the view that individuals with agrammatism are missing portions of the syntax. Instead, their comprehension deficits are argued to reflect varying degrees of processing impairment in the context of spared syntactic knowledge.

Kljajevic and Murasugi (2010) focused on comprehension of wh-dependencies in Croatian, reporting the results of three individuals with Broca's aphasia and three individuals with mixed aphasia in an act-out task. Contrary to most cross-linguistic findings, no asymmetries were detected in this study regarding the contrast between subject and object questions with *tko* 'who' and *koji* 'which' in the performance of individuals with Broca's aphasia, and those in the mixed group performed better on object than on subject extracted questions. This is attributed to the role of morphological information in free word order languages. However, contradictory results can be found in the literature (cf. Jovanov, 2011 below).

Finally, Jovanov (2011) reports the performance of two Serbian-Greek bilingual speakers with Broca's aphasia in sentence-picture matching, an act out task, grammaticality judgement and sentence repetition in order to observe word-order comprehension (canonical vs. non-canonical constructions) in discourse and non-discourse related structures. Additionally, she includes results from a third (monolingual Serbian-speaking) individual in a sentence-picture matching task with semantically reversible sentences (e.g. *The cat that the dog is chasing is black*, where the correct interpretation relied on syntactic structure only, unlike *The ball that the boy is kicking is red*, which provides semantic cues for interpretation). Focusing on Serbian alone, on average, in the first sentence-picture matching task that included left and right object dislocations, focus structures, subject and object restrictive relatives with or without modifiers (see examples below), the first two participants performed below chance with focus (19% correct), S-O (8.5% correct) and O-O structures (8.5% correct), and at or above chance with dislocations (50% correct), S-S (75% correct) and O-S structures (41.5% correct).

(9) a. Starica prati nju, ženu. (right dislocation without modifier)
old woman-Nom follow-3sg her-Pr woman-Acc
The old lady is following her, the woman.
b. Muškarca s kišobranom, njega gura policajac. (left dislocation with modifier)
man-Acc with.umbrella him-Pr push-3sg policeman-Nom
The man with an umbrella, the policeman is pushing him.
c. Starica šuta DEVOJČICU SA SLADOLEDOM. (focus structure with modification)
old.woman-Nom. kick-3sg girl-Accwith.ice cream
The old woman is kicking the GIRL WITH THE ICE-CREAM.
d. Medicinska sestra šuta devojku koja drži tašnu. (subject restrictive relative)
nurse-Nom kick-3sg girl-Acc who-Nom.f hold-3sg bag-Acc
The nurse is kicking the girl who is holding a bag.
e. Policajac koga pozdravlja žena ljubi staricu. (object restrictive relative)
policeman-Nom who-Acc.m greet-3sg woman-Acc kiss-3sg old. woman-Acc
The policeman that the woman is greeting is kissing an old lady.

The second picture-matching task compared dislocations and focus. The performance of one additional individual with Broca's aphasia showed an asymmetry between SVO and OVS constructions in addition to an effect of the presence of clitics vs. strong pronouns in the dislocation condition. The monolingual Serbian speaker with aphasia (SA3) produced 75% correct responses in SVO dislocations with clitics as opposed to 95% correct responses in SVO dislocations with full pronouns (10a), while his accuracy rates decreased for OVS constructions (45% correct with clitics vs. 50% correct with full pronouns, (10b)). The SVO – OVS effect was also shown to hold in the focus condition, with 95% correct responses for SVO compared to 60% correct responses for OVS (10c).

(10) a. Starac je šuta, staricu. (S-Cl-V-O) vs. Starac šuta nju, staricu. (S-V-Pr-O)
old man-Nom her-cl kick-3sg old.woman-Acc
The old man is kicking her, the old woman.

b. Policajca, gleda ga devojka. (O-V-Cl-S) vs. Policajca, njega gleda devojka. (O-Pr-V-S)
policeman-Acc look-3sg him-cl girl-Nom
The policeman, the girl is looking at him.
c. Devojka pozdravlja STARCA. (S-V-O) vs. STARCA pozdravlja devojka. (OVS)
girl-Nom greet-3sg old man-Acc
The girl is greeting the OLD MAN.

Taken together, the sentence-picture matching tasks revealed general above chance performance on constructions in canonical (SVO) order. Theta-role reversal was found to be by far the most frequent error type in OVS. The level of performance was found to be low on object relatives, but impairment was also found in subject relatives.

Contrary to Kljajevic and Murasugi (2010), in the prompted act out-task with subject and object questions Jovanov (2011) found a dissociation between *who* and *which* questions (92.5% correct vs. 47% correct, respectively) in the performance of two individuals with Broca's aphasia. Additionally, while canonical wh-questions were produced 78% correct, their non-canonical equivalents turned out to be more problematic, as they were correctly produced only 61.5% of the time.

The grammaticality judgement and the sentence repetition tasks were aimed at observing whether individuals with aphasia comprehend and produce case and S-V agreement in grammatical and ungrammatical constructions. Although accuracy rates were similar across tasks for grammatical sentences, a task dependency effect can be observed in the ungrammatical condition, with sentence repetition leading to a higher number of errors. The results of the two participants across tasks are reproduced in Table 1 below:

Table 1: Average accuracy for repetition and grammaticality judgement in two individuals with Broca's aphasia.

Grammatical sentences	**SVO (agreement)**		**VOS (agreement)**		**SVO (case)**		**VOS (case)**	
	%	n=16	%	n=16	%	n=16	%	n=16
RT	75	(12/16)	25	(4/16)	97	(15.5/16)	44	(7/16)
GJ	78	(12.5/16)	47	(7.5/16)	97	(15.5/16)	56	(9/16)
Ungrammatical sentences	**SVO (agreement)**		**VOS (agreement)**		**SVO (case)**		**VOS (case)**	
	%	n=16	%	n=16	%	n=16	%	n=16
RT	0	(0/16)	34	(5.5/16)	0	(0/16)	15	(2.5/16)
GJ	100	(16/16)	97	(15.5/16)	100	(16/16)	94	(15/16)

RT: repetition task; GJ: grammaticality judgement

(Jovanov, 2011: 302)

In line with Milekić et al. (1994), participants in Jovanov's study achieved mostly above chance performance in the grammaticality judgement task indicating retained ability to recognize S-V agreement and/or case marking errors. In the sentence repetition task, accuracy rates were shown to decrease with greater difficulties in the repetition of ungrammatical constructions. Altogether, there is significantly better performance on SVO than on VOS clauses.

Summing up, studies of BCMS speakers with non-fluent aphasias reveal short utterances with a strong preference for canonical structures and lost patterns of intonation. While lexical categories and sensitivity to closed-class morphology and subcategorization requirements in comprehension are better preserved (e.g. nouns, nominative case, infinitives), there are consistent problems with inflected elements (e.g. tense, with the present as the better preserved form) and with free standing functional elements (e.g. clitics). Thematic-role assignment is affected by the patients' inability to use case information and their residual use of positional information, with animacy and convergence of cues showing favouring effects. However, comprehension and grammaticality judgement skills indicate that the content of functional elements is not lost. As for the contrast between *who* and *which* questions, binding a wh-phrase with a wh-trace is still possible in cases of non-fluent deficits. Regarding wh-dependencies, and despite contradictory results, variability is found across non-fluent syndromes with no subject-object asymmetries in the case of individuals with Broca's aphasia and object questions better preserved in cases of mixed aphasia. Linguistic knowledge seems to be less accessible in complex contexts that place heavy processing demands and heavily rely on working memory (Smith &

Mimica, 1984; Lukatela, Crain & Shankweiler, 1988; Milekić, Bošković, Crain & Shankweiler, 1994; Zei & Šikić, 1990; Kljajevic & Murasugi, 2010; Jovanov, 2011). With the exception of wh-dependencies, which need to be further investigated, this view is consistent with the traditional patterns attested cross-linguistically (Goodglass & Kaplan, 1972, 1983; Miceli et al., 1984, 1989; Grodzinsky 1990; Menn & Obler, 1990; Thompson, Shapiro, Li & Schendel, 1994; Thompson, Lange, Schneider & Shapiro, 1997; Thompson, 2003; Caplan, 2006; among many others).

The studies presented so far focused on non-fluent aphasias. Interestingly, Kljajević and Bastiaanse (2011) address the issue of a possible dissociation between fluent and non-fluent aphasias. Using the *Test for Assessing Reference of Time* (TART, Serbian version: Kljajević & Bastiaanse, 2008), the authors investigate the production and comprehension of time reference in four Serbian-speaking individuals with fluent aphasia. Similar to individuals with non-fluent aphasias, the production results show ceiling performance for the present verb forms and relatively spared ability to produce verb forms referring to the future (87.5% correct). However, the production of verb forms referring to the past was found to be impaired. In comprehension, the results are better for the present (85% correct) and past (81.25% correct) than the future (63.75% correct). Differences emerge in terms of the error pattern. While non-fluent individuals produce within-time-frame errors with non-past reference, out-of-time-frame errors are attested for reference to the past. On the contrary, fluent individuals tend to maintain the correct time reference, be it past, present or future and select a non-target tense within any of these temporal frames.

Fluent and non-fluent populations have been directly compared by Popov (2013), who reports the results of a sentence production task with three fluent and four non-fluent individuals with aphasia, all of whom are native speakers of Serbian. Unergative and transitive verbs were found to be better preserved than unaccusatives and anticausatives in both groups (unergatives: 97.1%; transitives: 87.5%; unaccusatives: 67.1%; anticausatives: 38.3%). As in Kljajević and Bastiaanse's (2011) study, the differences mainly reduce to the error pattern. While non-fluent subjects show a tendency towards the transitivization of non-transitive entries (>25% of errors), which is a manipulation of argument structure, fluent individuals display morphological errors in the form of tense and agreement substitutions and

finiteness omission along with omissions of the main verb, which account for over 50% of the errors in this group. This asymmetry between fluent and non-fluent individuals is consistent with other cross-linguistic observations (Miceli, Silveri, Villa & Caramazza, 1984; Zingeser & Berndt, 1990).

Some studies have specifically focused on recovery patterns. Vukovic, Vuksanovic and Vukovic (2008) describe the recovery patterns and the correlation of language and cognitive functions in patients with post-traumatic language processing deficits (n = 37) and in patients with aphasia following a stroke (n = 34). The data gathered in the acute phase and 6 months later indicate that patients with post-traumatic language processing deficits display a different recovery pattern and a different pattern of correlation between language and cognitive functions compared to patients with aphasia following a stroke, with significantly better recovery and greater correlation within language and cognitive functions, and language functions and other aspects of cognition in patients with post-traumatic language processing deficits. Individuals in this group performed significantly better in sentence repetition and higher verbal fluency tasks and in short-term and long-term verbal memory tasks. Focusing on individuals with aphasia alone, in the acute phase not all language functions were found to be interrelated (e.g. mean score for verbal fluency of 2.18 vs. 14.88 for naming), and language functions were not tightly correlated with the tested cognitive functions (e.g. mean score for reasoning ability of 25.38 in the acute phase). However, language functions and short-term verbal memory (mean score of 1.5 and 5.09, respectively across phases) have been found to correlate, pointing towards the specific role of memory in the recovery of language functions in individuals with aphasia. Although the study allowed for a better understanding of the relationship between language and cognitive functions, as well as a better understanding of the factors influencing recovery, its major shortcoming was that the sample included patients with very diverse lesions and diagnoses, which may have prevented the emergence of more fine grained correlations in this group.

4. Discussion and suggestions for further research

For the most part, the studies on BCMS speakers with developmental or acquired disorders reviewed in sections 2 and 3 replicate previous cross-

linguistic findings. As observed in section 1, despite an increasing tendency to characterize typologically different languages, the traditional literature includes mostly results from Romance and Germanic languages (English, French, and Italian). Research on language in clinical populations in South-Western Slavic varieties will thus further contribute to the literature on language in disordered populations that seeks to reveal facts about the language faculty that ordinary linguistic inquiry cannot. Moreover, these languages may be crucial in providing evidence for previously existing, or even competing, hypotheses about linguistic competence of these populations (e.g. as in the reviewed study on binding in Serbian Down syndrome).

To further advance the field, it is necessary to overcome hurdles such as the lack of descriptions of linguistic phenomena that rely on current theoretical frameworks in these languages, lack of data on stages of linguistic development in TD children to allow comparisons to disordered populations, and of course the lack of standardized tests of linguistic abilities that can establish levels of typical functioning during different stages of linguistic development.

With regard to linguistic topics for further research, the verbal system of BCMS looks most promising, as suggested in Martínez-Ferreiro and Halupka-Rešetar (2014). Deficits with the production of verbs are common to different developmental and acquired disorders (e.g. SLI and aphasia). Since verb production seems to be influenced by syntactically relevant argument-taking properties of verbs (Levin & Rappaport-Hovav, 1995 *apud* Thompson, 2003), one of the questions that the BCMS verb system might help to refine is how anticausatives (*Vrata su se otvorila.* 'The door has opened.') fare with respect to the argument structure complexity hypothesis (Thompson, 2003), i.e. how they rank with respect to naming and categorization relative to other intransitive verbs, as well as transitive and ditransitive verbs. Among other linguistic particularities of the Slavic varieties which deserve further investigation are the following: the fact that word order variation does not affect truth value, apparent case marking optionality, wh-movement and multiple wh-questions, as well as the issue of ordering of wh-phrases and the question of exhaustivity, wh-extraction, agreement in coordinated phrases, clitics, argument structure, voice and morphosyntactic operations, negation, among others. Research is also needed regarding the effect digraphia may have on processing in Serbian and its connection

with deficits in writing and pathologies related to writing, such as dyslexia. Needless to say, research into language disorders in BCMS also faces the challenge of standardizing numerous research tools and instruments which will help develop more effective assessment and therapeutic methods. We hope that some of these gaps will be filled in future editions of the Novi Sad workshop on *Psycholinguistic, neurolinguistic and clinical linguistic research*.

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EFFECT OF ANIMACY AND AGENTIVITY ON THE PROCESSING OF AGREEMENT IN SERBO-CROATIAN[1]

Abstract: In this paper we investigate the role played by animacy and agentivity in agreement of the verb with a coordinated subject in Serbo-Croatian. Serbo-Croatian coordinated subjects with mixed gender values allow for three patterns of agreement: agreement with the first member of coordination, agreement with the last member and agreement with the entire coordination. We conducted two experiments with coordinated subjects, one of which involved singular members of coordination and acceptability judgments, with four different types of coordinated subjects, involving: conjunction in affirmative contexts, conjunction in negative contexts, negative concord conjunction and disjunction and another involving plural members of coordination and elicited production, with disjunction and conjunction only. Their goal was to empirically test whether agreement patterns depend on factors such as animacy and agentivity and what their behavior with respect to the subject-verb agreement in SC tells us about the structural and processing modelling of agreement. Our results show that both factors investigated have a strong influence on the choice of agreement, but with different patterns of effects. We conclude that agreement is a multi-component phenomenon, ranging from syntax to semantics and phonology, and that the degradation observed in certain patterns is typically either due to the syntactic configuration (in particular the specification of the vP, implying that agreement in SC does take place in vP), or due to a semantic or pragmatic degradation, which gets sharpened with animate subjects.

Keywords: coordinated subjects, single conjunct agreement, animacy, agentivity, Serbo-Croatian

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[1] Our researh is part of a bigger project, *Coordinated research in the experimental morphosyntax of South Slavic languages* (EMSS), which includes teams from seven partner institutions (University College London, University of Niš, University of Nova Gorica, University of Novi Sad, University of Sarajevo, University of Zadar and University of Zagreb), with more information available at https://www.ucl.ac.uk/pals/research/linguistics/research/leverhulme

1. Introduction: Agreement in Slavic languages

Agreement is one of the most prominent phenomena characteristic of human language. In South Slavic languages, it shows a range of peculiar properties, strongly indicative of its complexity, as well as of its precise mechanics (Corbett 1983, 2002, 2009; Arsenijević & Alsina 2012, Arsenijević 2015a, Marušič et al. 2007, Marušič & Nevins 2010, Marušič et al. 2015, Willer Gold et al. 2015). In the study presented here, we focus on language data gathered experimentally from Serbian speakers (it is relevant though that the comparative South Slavic research conducted so far indicates that there is no radical variation across the dialects of the Serbo-Croatian (SC) area, and even Slovenian, see Willer Gold et al. 2015).

SC shows three different patterns of agreement of the verb with a coordinated subject, when the members of coordination have different gender values: 1. agreement with the first member of coordination (FCA), 2. agreement with the last member of coordination (LCA, together with FCA forming the class of single member of coordination agreement, SCA) and 3. default, or default agreement, i.e. MPl.[2] Previous theoretical and experimental research indicates that these patterns are analytically best represented in terms of 1. closest member of coordination agreement (LCA preverbally and FCA postverbally), expemplified in (1) – agreement with the member of coordination which is linearly closest to the verb, 2. highest conjunct agreement (always FCA), as in (2) – agreement with the member which sits in the highest structural position within the coordination, and 3. default agreement (agreement with the entire coordination or default, masculine plural agreement), as in (3) (see Willer Gold et al 2015, Marušič et al. 2015, Arsenijević 2015a, Arsenijević & Mitić 2015 for theoretical and experimental arguments for this type of analysis). As clear from examples (1-3), in SC, agreement between the subject and the verb is in number, gender and person, both pre-verbally and post-verbally (we do not discuss other constituents, such as adjectives, relative pronouns or personal pronouns, which also undergo agreement). Note

[2] The situation is in fact a little bit more complicated when cases with all the members of coordination being feminine or neuter, there are two patterns which may be considered as default agreement: the gender of all the members of coordination (because then the group formed is also of that gender) and masculine (because it is the default gender). This issue is not relevant for our research, and hence we do not dwell on it any further in this paper.

that in (1-3) and most other examples, as well as in our acceptability judgment experiment 1, we give coordinated singulars, which are somewhat restrictive regarding agreement with a single member of coordination: examples in (1-2) all improve with plural members of coordination.

1. ??Izveštaj i pismo nije primljeno.
   report.MSg and letter.NSg NegAuxSg received.NSg
   'The/a report and the/a letter were not received.'

1'. ?Nije primljen izveštaj i pismo.
   NegAuxSg received.MSg report.MSg and letter.NSg
   'The/a report and the/a letter were not received.'

2. ??Izveštaj i pismo nije primljen.
   report.MSg and letter.NSg NegAuxSg received.MSg
   'The/a report and the/a letter were not received.'

2'. Nije primljen izveštaj i pismo.
   NegAuxSg received.MSg report.MSg and letter.NSg
   'The/a report and the/a letter were not received.'

3. Izveštaj i pismo nisu primljeni.
   report.MSg and letter.NSg NegAuxPl received.MPl
   'The/a report and the/a letter were not received.'

3'. Nisu primljeni izveštaj i pismo.
   NegAuxPl received.MPl report.MSg and letter.NSg
   'The/a report and the/a letter were not received.'

One of the arguments in favor of the family of analyses in terms of the closest and the highest member of coordination comes from the fact that agreement with the last member of a coordinated subject postverbally, as in (4) is judged as ungrammatical (but see Arsenijević & Mitić 2015 and willer Gold et al. 2015, and note that different approaches have been proposed that capture the same facts, such as Puškar & Murphy 2015).

4. *Nije primljeno izveštaj i pismo.
NegAuxSg received.NSg report.MSg and letter.NSg
int. 'The/a report and the/a letter were not received.'

Previous research payed a lot of attention to the investigation of agreement with subjects consisting of conjoined plurals. The reason is that as mentioned, it has been considered that only conjoined plurals allow for single conjunct agreement (e.g. Bošković 2009: 461 says "Number specification also matters. In all of the above cases involving [Single Conjunct Agreement], the individual conjuncts are plural. When the individual conjuncts are singular, regardless of the gender specification of individual conjuncts the participle must be masculine"). This partial coverage of the theoretically available patterns is unfortunate for at least the following three reasons: 1) the quoted generalization above that SCA in gender is only available with conjuncts of plural number should be subject to experimental testing, 2) without both values of number, we cannot investigate the interaction between number and gender in respect of agreement and 3) with only plural members of coordination, we can only test how gender agrees, but not whether number as well shows single conjunct agreement. In order to overcome these issues, we based our data set on both coordinated singulars and plurals. As there was a risk that the low level of acceptability and frequency in production of single conjunct agreement with singular members of coordinated subjects leads to floor effects, we included other types of coordination as well, in particular those that improve SCA. We thus included coordinated subjects involving disjunction (5) and negative concord conjunction (6), both of which show a smaller difference in acceptability with singular members of coordination between default and single conjunct agreement.

5. (?)Jovan ili Marko je došao na sastanak.
Jovan.MSg or Marko.MSg AuxSg come.MSg to meeting.
'Jovan or Marko came to the meeting.'

5’. ?Jovan ili Marko su došli na sastanak.
Jovan.MSg or Marko.MSg AuxPl come.MPl to meeting.
‘Jovan or Marko came to the meeting.’

6. Ni Jovan ni Marko nije došao na sastanak.
n-and Jovan.MSg n-and Marko.MSg NegAuxSg come.MSg to meeting
‘Neither Jovan nor Marko came to the meeting.’

6’. Ni Jovan ni Marko nisu došli na sastanak.
n-and Jovan.MSg n-and Marko.MSg NegAuxPl come.MSg to meeting
‘Neither Jovan nor Marko came to the meeting.’

As we decided to control for the influence of the particular gender values, we only used feminine (F) and masculine (M) nominals in the metalinguistic experiment (henceforth Exp1) and only F and neuter (N) in the production experiment (henceforth Exp2). In the metalinguistic experiment, we always included two F members and one M member, in order to counterbalance the default nature of M.

In previous research, semantic and syntactic factors such as animacy, agentivity, collective vs. distributive interpretations, tense and aspect of the verb have been mentioned as potentially relevant for agreement (e.g. Corbett 1983, 1991, 2002, 2009, Comrie 1989, Kirchner 2001, Leko 2010, Harwood 2012, Bamyaci et al. 2014, Puškar & Murphy 2015). The question is what roles syntax and semantics play in explaining number and gender agreement with subjects involving coordinated nominal expressions, in particular when these are singular in number. In order to answer this question, we tested the effects of two properties of nominal expressions playing both syntactic and semantic roles, animacy and agentivity. While both these properties have effects both in syntax and in semantics, agentivity has been argued to have a wider range of syntactic effects and a stronger syntactic

reality, manifested in the projection labeled *v*P (e.g. Kratzer 1996, Hale & Keyser 1993, Marantz 1984). The effects of animacy, on the other hand, are typically captured indirectly, via other syntactic and morphological phenomena such as selectional restrictions or differential case marking.

The paper is organized as follows. In section 2 we overview the relevant facts of conjunct agreement, its behavior and structure, and the previous theoretical and experimental accounts. Section 3 introduces the relation between animacy and agentivity on the one hand and agreement on the other. In section 4 we present the design and discuss the results of our two conducted experiments aiming to test the effects of animacy and agentivity on the processing of agreement in SC. Section 5 concludes the paper.

2. Conjunct agreement in Slavic languages: previous research

There are two types of accounts and two types of predictions made regarding the role of properties such as animacy and agentivity: those stemming from theoretical linguistic consideration and those related to language processing. We examine them in the following two sections.

2.1 Theoretical accounts

Conjunct agreement is a term used for the agreement of the verb with a single member of a conjoined subject. It is pre-theoretically described as the agreement with the first (FCA), or with the last conjunct (LCA), and it has been analyzed in several different ways:

(a) as the agreement with the specifier (FCA), or with the complement (LCA) when the specifier is blocked by complex pied piping issues (Bošković 2009, 2010),

(b) with the linearly closest or with the highest (Corbett 1983, 2002, 2009, Marušič et al. 2007, Marušič et al. 2015, Willer-Gold et al. 2015),

(c) with two different types of conjunction structures (Franks & Willer Gold 2014) or,

(d) with the highest or with the lowest member of coordination resulting from different orders in the application of Agree, Merge and Move (Puškar & Murphy 2015).

Marušič et al. (2007) propose two possible scenarios for the agreement with two-conjunct subjects involving an F and an N conjunct: agreement with the functional projection of conjunction, ConjP/&P, or agreement with the linearly closest member of coordination.[3] Bošković (2009) argues that what appears as last conjunct agreement is in fact agreement with the complement, after agreement failed with each of the specifiers starting with the highest conjunct due to ambiguous targets for movement. Franks and Willer Gold (2014) argue for two different underlying structures for phrasal conjunction, one including an &P for each conjunct, and another which is structurally flat, linking default and default agreement with the former, and single conjunct agreement with the latter. Puškar and Murphy (2015) model agreement in terms of the directionality of agreement and the ordering between Agree, Merge and Move. In a somewhat simplified view, if upward agreement inside the conjoined subject preceeds the merge of the specifier, LCA obtains and movement of the subject necessarily follows. Other ordering possibilities yield FCA or default with or without the movement of the subject. Arsenijević (2015a) proposes an analysis based on a phonologically null pronoun introduced on the top of the coordinated structure (a modification of Citko 2004). When the pronoun is marked for the relevant features, default agreement (Def) obtains in syntax, otherwise, depending on other features such as animacy, agentivity or availability of the collective interpretation, either highest (H) obtains in syntax, or the pronoun is spelled out unspecified for gender. In the latter case, agreement in gender obtains in phonology, as the agreement with the linearly closest member of coordination (C).

The three families of analyses give different prediction regarding the relation in the focus of this paper, the one between the different available patterns of agreement on the one hand and animacy and agentivity on the other. Approaches assuming a purely syntactic account, i.e. those in which all the patterns of agreement are purely syntactically derived predict that if any effects obtain, all the well formed agreement pattern in each configuration will be affected by animacy and agentivity in a similar way. In Bošković (2009) and Franks and Willer Gold (2014) this means LCA and

[3] The subject follows the verb and the verb agrees with the highest conjunct. The explanation can be found in the view of the structure of the coordination phrase. FC is on the specifier position and only FC has a solution for agreement with the verb.

Def preverbally and FCA and Def postverbally, and in Puškar and Murphy (2015) FCA, LCA and Def preverbally and FCA and Def postverbally.

Marušič et al. (2007, 2015), with an important role of the PF, predict an asymmetry between the patterns derived solely in syntax, i.e. FCA (their H) and Def, and the pattern which involves a role of phonology, i.e. C (LCA preverbally and at least some of FCA postverbally). The former are predicted to interact equally with a predominantly semantic property like animacy and with the one with a stronger syntactic reality like agentivity, while the latter are expected to have a bidirectional interaction with the more syntactic phenomena, in this case with agentivity, and a unidirectional interaction with a primarily semantic phenomenon with a certain syntactic reality such as animacy. The reason is that, assuming the inverted Y model of grammar, a semantic phenomenon can only have indirect effects at PF, via its impact on the syntax, and a PF phenomenon cannot have any semantic effects.

Finally, Arsenijević (2015a) postulates three scenarios: a pronoun specified for gender (where LF and pragmatics introduce a higher or lower degree of degradation for certain values), a pronoun unspecified for gender which syntactically receives the gender of the highest member of coordination (surfacing as FCA) and a pronoun which remains unspecified in syntax, which like in Marušič et al. leads to the specification of gender on the verb at the interface with phonology, by copying the value of the linearly closest member of coordination (LCA preverbally – here marked C, FCA postverbally – here marked HC). The prediction of this type of accounts is that Def, which with the F&N combination of conjuncts necessarily results from a null pronoun lexically specified for the default gender will show no sensitivity either to animacy or to agentivity. The reason is that this scenario involves no syntactic computations to determine the gender of the pronoun (because it is already specified), and no last resort phonological computations copying gender to the verb (because the agreement fully takes place in syntax). It is thus not sensitive to animacy because its default agreement is a safe bet at LF and in pragmatics, and to agentivity because irrespective of the syntactic structure, it will trigger the default syntactic agreement on the verb. Asymmetric sensitivity is expected from H and C. H, the pattern which involves a syntactic gender assignment to the pronoun but no phonological copying onto the verb (because the verb agrees in syntax) is expected to be degraded by animacy and facilitated by agentivity. The degradation is due

to the fact that the gender value copied from the highest member of coordination may be (and in our first experiment systematically is) incompatible with the semantic representation of the coordinated subject. Faciltation by agentivity is predicted because agentivity implies a different syntactic structure (in particular a strong, agentive vP), which strengthens syntactic agreement implied in H. Yet a third pattern of behavior is expected from C, the pattern of agreement involving the copying of gender at the interface with phonology. This pattern occurs in the derivations which do not spell out any gender value to LF. Hence, animacy, which requires specified gender at LF (animate entities are implied to bear gender) is expected to degrade it. Moreover, this pattern is in competition with H, as they both occur when the null pronoun is unspecified for gender in the numeration. Therefore, agentivity is predicted to have a negative effect on C, as it facilitates H. It is not predicted to have a degrading effect on HC, because in HC the two strategies give the same surface outcome, and hence no actual competition obtains. As elaborated in section 4, the last type of analysis is supported by the experimental results reported.

7. A tabular representation of the predictions of the three types of theoretical approaches

Approach	Prediction animacy vs. agentivity
Purely syntactic	Similar for all patterns
Syntax+PF	Similar for Def and H, different for C
Syntax+PF with a pro	No effect for Def, different effects for H, yet a third pattern for C

2.2 Psycholinguistic accounts

In psycholinguistic literature (e.g. Eberhard et al. 2005, Badecker & Kuminiak 2007, Mirković & MacDonald 2013), three basic accounts for conjunct agreement have been proposed, based on three more general models of the processing of grammar: the Marking and Morphing account, the competition account and the misidentification account, which include different types of factors, both non-syntactic and syntactic. The first account is more explicit about the distinction between syntax and the lexicon and is formulated under the assumption that conceptual and grammatical infor-

mation work together. The competition account gives the central role to the competition between different factors, not only syntactic, but also semantic and phonological, in the mapping between the content of the message and the string that phonologically represents it. The misidentification account looks for an explanation for the optional patterns of agreement in the interplay of memory and the competing forms, seeking to explain the occurrence of multiple different forms in the failure to identify the correct form due to memory constraints. The three types of models differ in the degree of contribution of the different factors involved, in particular in the "strong emphasis on the syntactic properties in the Marking & Morphing model, and an assumption that syntactic properties are represented as abstract features in the lexicon", vs. the tendency of the other two models to assign the central role to semantic phenomena or to processing and memory limitations (Mirković and MacDonald 2013: 27).

In short, Marking and morphing models are designed to capture different effects of the factors stemming from the lexical access and selection and semantics, from those coming from the morpho-syntactic computations. It hence predicts that animacy and agentivity may give the same or different effects depending on the pattern of agreement, or more precisely the component that plays a major role in its derivation: the lexicon and semantics (for default agreement), syntax (for H) and morphology and phonology (for C).

The competition account predicts that animacy and agentivity each show uniform effects for all patterns of agreement, because they are only two among a number of factors competing in a shared space to determine the surface pattern of agreeement.

The misidentification account predicts that animacy, which increases the prominence of the gender features by making them interpretable, yields a stronger contrast between the degraded and well-formed examples in comprehension, and a higher rate of the default agreement in production. For agentivity, it makes no clear prediction, except perhaps for a general decline in the contrasts between the different agreement patterns, due to a richer set of competing properties (with agentivity added).

8. A tabular representation of the predictions of the three types of processing approaches

Approach	Prediction animacy vs. agentivity
Marking and Morphing	Possibly differently directed effects for each pattern
Competition	Uniform effects
Misidentification	Stronger contrast for animacy, unclear for agentivity

As argued in more detail in section 3, our experiments lend support to the Marking and Morphing family of accounts (Eberhard et al., 2005). In this type of accounts, agreement unfolds in two stages: marking and morphing. Franck (2011: 1072) summarizes it as follows: "The major property of the model is the separation between two functionally distinct components. Marking is the process that imports notional number from the semantics into the syntax. It operates at the interface between the message level and grammatical encoding, and is assumed to be the locus of conceptual influences on agreement. Morphing is a set of interrelated operations. Its first role is to match number-relevant features from the syntax (number marking) and the lexicon (number specifications). Morphing also binds morphological information to structural positions. Finally, morphing transmits number features to structurally controlled constituents (e.g., to verbs)." This approach is more restricted in respect of the interplay of different factors than its competitors, as it predicts that the conceptual contribution will come before the morpho-syntactic contribution, and hence that they will enter implicational and causational rather than flat competitive interactions.

3. The roles of animacy and agentivity in the computation of agreement

This section additionally motivates our choice of the properties of animacy and agentivity to be investigated, by giving some additional insight into the direct and indirect ways these properties are related to agreement, and to the features of gender and number. In previous research, at the theoretical and descriptive level, effects of animacy and agentivity on agreement have been attested in different languages (see Corbett 1983, 2009, for

Georgian, Mundary, Comrie 1989, Kirchner 2001 and Bamyaci et al. 2014 for Turkish, Harwood 2012 for English, Leko 2010 and Puškar & Murphy 2015 for Serbo-Croatian, i.e. Bosnian). Corbett (1983, 2009), for Slavic languages in general, and Leko (2010), for Bosnian, show evident effects of animacy on subject-verb agreement and predict several options for its computation.[4] Bock and Miller (1991: 81) suggest that "animacy matters to subject designation, which in turn matters to agreement". Barker, Nicol and Garrett (2001: 91) found that both animacy and semantic relatedness have reliable effects on error rates, "indicating that the mechanism involved in implementing agreement cannot be blind to semantic information."

Animacy is identified as a significant factor playing a role in number and gender resolution (Puškar & Murphy 2015 for Serbo-Croatian). In gender agreement, the link is very straightforward. With animate nouns, grammatical gender establishes a relation with the semantic gender, i.e. the former may be taken to carry a presupposition about the latter. With inanimate nouns, morpho-syntactic gender is a pure formal feature. However, animacy is also important when it comes to the specification and interpretation of grammatical number.

In line with the theoretical notion of animacy hierarchy, animate nouns have been found, both experimentally and descriptively, to support singular and plural agreement, inanimate nouns favor singular agreement (Bamyaci et al. 2014 for Turkish on experimental data, Stevanović 1979 for Serbian in a descriptive approach).[5] Masculine agreement is possible with morpho-syntactically feminine animate nouns, but not with morpho-syntactically feminine inanimate nouns (Bhatt & Walkow 2013). Animacy as a property of the noun not only has direct effects on agreement, but also has the ability to restrict the range of influence of some other factors (such as precedence, see Corbett 2002, 2009).

[4] Corbett generalizes on a corpus study that animacy as well as precedence of the subject with respect to the predicate almost completely exclude the occurrence of Sg agreement in number with conjoined subjects, while in the opposite cases, inanimate subjects and predicates preceding subjects, Sg is represented in similar percentages as Pl agreement (Corbett 1983, 2009).

[5] Bamyaci et al. (2014: 258) explain that in linguistic sense animacy "indicates that an entity is capable of purposefully acting or intentionally instigating an event" – in line with the view in Folli and Harley (2008) and consider for "animacy hierarchy to be based on the likelihood of a referent to act as an agent in an event."

Recent literature comes up with a scalar notion of animacy, with a different probability of effects of items with a higher from those with a lower degree of animacy (for the sub-categorization into higher and lower animates, see Grimm 2012). Corbett (1991: 228), referring to Krifka (p.c.), as well as Braun and Haig (2010), gives empirical support to the view that animacy can be realized in different degrees, yielding a different degree of impact on agreement as well. Animacy has been brought in connection with individuation and the prominence of atomic parts of pluralities, another property relevant for number agreement. In Grimm's view, "the higher in the scale a noun type is, the more salient the unit interpretation becomes" (Grimm 2012: 56). Semantic properties of the noun correlate with some of its syntactic features, such as grammatical number, which appears to be responsible for the accessibility of units (see Grimm 2012).[6] Thus, animate entities which are higher on the hierarchy scale are more clearly individuated, according to Grimm (2012: 84).

É. Kiss (2012) points out another important link. Animate members of coordination in the subject position are more likely to be collective agents, i.e. their intentionality allows them to join forces in a collective action. Inanimate coordinated subjects have a narrower range of semantic possibilities to receive a collective interpretation, namely only the causative (where collectivity must be imposed by additional contextual pressure) and the unaccusative or middle type of interpretation, all of which are in principle also available to animate members of coordination.[7]

As suggested by Folli and Harley (2008), the animacy hierarchy can well be defined in terms of the capacity to occur as an agent and the properties that this agent may have, such as controlling the action, or merely causing it. Already this brings about agency as another potentially important factor for the modeling of the processing of agreement. However, as already pointed out, agentivity differs from animacy in having been argued to have a structural syntactic representation, i.e. to correspond to a particular specification of the syntactic projection labeled voice phrase (Kratzer 1996) or simply vP/vP (Hale & Keyser 1993, Folli & Harley 2008, among many others).

[6] Animate nouns and their behaviour is connected with the individuation, which triggers agreement strategies.

[7] We thank an anonymous reviewer for drawing our attention to this aspect of the relation between animacy and coordinated subjects.

Previous research confirms the effects of the link between agentivity and animacy through a restricted behavior of agentive verbs in being used only with the animate entities, which brings them in a correlation with a promoted individuation (Mirković & MacDonald 2013). In Russian, agentive verbs in a sentence with quantifier noun phrases appear more frequently in plural forms and hence "event semantics can influence subject-verb number agreement by modifying individuation of the referents of the NP" (Mirković & MacDonald 2013: 8).[8] Previous research also shows that the choice of the verb form is influenced by the morpho-phonological properties of the noun, such as the homophony among nouns and forms available in the speakers' experience. Robblee (1993) investigated the relation between the semantics of a verb and individuality and proposed that particular types of verbs attract specific types of nouns and have effect on the number: agentive verbs are more prominent with animate nouns and with plural agreement. Verb meaning too is recognized as one of the factors which "can promote or reduce the degree of individuation in the event participants" (Mirković & MacDonald 2013: 8).[9]

In parallel with its link with animacy, agentivity is closely linked with a particular syntactic projection responsible for the number and interpretation of the structural arguments taken by the verb, typically marked vP (Hale & Keyser 1993, Folli & Harley 2008). Arguments have been presented in the literature that vP is one of the projections in which the agreement between the subject and the verb takes place. In particular, this is the position where the lexical verb (especially if it surfaces as a participle) gets its agreement features, while the finite verb, in complex verb forms the auxiliary, agrees in the tense projection, TP (see e.g. Rocquet 2010). Agentivity, as a strong value of vP, is therefore expected to support those patterns of agreement which target the lexical verb (the participle in complex verb

[8] Kirchner (2001) found agentivity to be a significant factor for explaining the properties of plural agreement in Turkish.

[9] Bamyaci et al. (2014) compare the interaction of the number on the verb, verb type and the degree of animacy and test the influence of the verb type on its number. Verb type did not show effect: neither a main effect, nor in the interaction with the number, animacy or both. They conclude that "the agentivity of the subject did not drive the effect that quasi-animates pattern more like animates than proper inanimates" (Bamyaci et al. 2014: 269).

forms) and which take place in syntax (that is H and Def in approaches like Marušič et al. 2007, 2015, or only H in approaches like Arsenijević 2015a).

Alsina and Arsenijević (2012) argue that in SC the auxiliary and the participle, as well as the copula and the predicative adjective, may have different values of number, in examples like (11). In (11a), the subject is morpho-syntactically FSg and semantically MPl. The form of the participle is ambiguous between FSg and NPl. As there is no way in which the participle can agree in NPl (but see Wechsler & Zlatić 2003, or Arsenijević 2015b for alternative analyses), the participle must be bearing a Sg value of number, while the auxiliary is clearly Pl. This view is further supported by examples such as (11b) where the instrumental case of the predicate disambiguates it as uncontroversially FSg, while the copula which sits in TP is again in plural.

11. a. Braća su stigla.
brother.MPl AuxPl arrived.FSg/NPl
'(The) brothers (have) arrived.'

b. Deca su smatrana gladnom.
Child.NPl AuxPl considered.FSg/NPl hungry.FSg
'(The) children were considered (to be) hungry.'

Puškar and Murphy (2015) argue that the agreement between the subject and the verb in SC takes place only in TP, and not in vP, a claim that can hardly be reconciled with the facts above (we are grateful to Andrew Nevins, p.c. for drawing our attention to this fact).

Based on the previous research, we may set the background of our experiments as follows. Animacy introduces additional restrictions in the processing of both gender and number agreement. Regarding gender, animacy renders it semantically interpretable, thus enriching the set of restrictions applying to the gender agreement as well. Regarding number, animacy has a similar effect, as it promotes individuation and collectivity (Grimm 2012, É. Kiss 2012), which in turn add complexity and strength to the semantic interpretation of grammatical number, again resulting in a larger set of constraints applying to the agreement on the verb. Agentivity is tightly linked with animacy, both with its defining role with respect to animacy (Folli &

Harley 2008), and as a property of the verb which sets its selectional restrictions to arguments with a certain degree of animacy. At the same time, agentivity has a structural syntactic reality through the vP projection, argued to be involved exactly in the agreement we are interested in: the agreement of the participle with the subject, involving number and, crucially, also gender. We expect thus that both animacy and agentivity show effects on both gender and number agreement. While rather flat competitive approaches like the competition approach and the misidentification approach predict that animacy and agentivity will have the same kind of effects, approaches of the Marking and Morphing family predict that animacy, as a conceptual factor will show a rather flat kind of effect on all the patterns of agreement, while agentivity, as a factor with a stronger syntactic reality, will show different effects on syntactic and non-syntactic agreement patterns. Approaches like Corbett (1991, 2002, 2009), in which default agreement is semantic while single conjunct agreement is syntactic, predict that effects of agentivity will split along this line: default agreement will be strengthened by agentivity unlike the single member of coordination agreement patterns. Approaches like Marušič et al. (2007, 2015), on the other hand, predict that default and highest member of coordination agreement, as syntactic strategies, will pattern together, contrasting with the closest member agreement, which takes place at the interface with phonology. Finally, in an approach like Arsenijević (2015a), in which default agreement is syntactically unrestricted, insensitive to syntax, and only semantically constrained, while highest is syntactic and closest is phonological, the prediction is that all three different agreement strategies may potentially show different behavior in respect of agentivity. We conducted two experiments to test these predictions.

4. The experiments: effects of animacy and in the processing of agreement

4.1 Experiment 1: design, tasks and goals in regard to the animacy effect

The first experiment (Exp1) was an acceptability judgment experiment on SC data, aimed mainly at estimating the relative acceptability of the singular agreement of the verb with a coordinated subject, and of the

effect of animacy on the acceptability of different patterns of agreement of the verb with coordinated subjects. It was based on an acceptability judgments task over a 5-point Likert scale (1 to 5, 1 for fully unnatural, 5 for perfectly natural), with unlimited time to give response. The experiment was conducted using Google Forms. All participants included in the experiment results are native speakers of SC, all non-linguists and without explicit linguistic education in the past five years (in order to prevent potential prescriptive influences). The total number of participants was 70, 41 female and 29 male. A consent form and a biographic questionnaire were administered in the beginning of each session.

Participants were presented with 96 contextualized sentences involving coordinated subjects, and instructed to judge the degree to which the sentence feels natural in the given context. The context for each sentence consisted of a preceding sentence the purpose of which was to control that the entire coordinated subject shares the same information structure status, because focus on the first member only could have consequences for the underlying structure (Bošković 2009), and to guarantee that the sentence is given the intended interpretation. Participants were given one context sentence and one critical sentence, for which they were asked to judge the degree to which it sounds natural in the given context. The polar valuer of the Likert scale were described as fully natural and fully unnatural. The experiment included 96 stimuli (no fillers or controls were included), covering a 2x3x2x2 factorial design over the following four variables:

(a) animacy (levels: animate, inanimate),
(b) agreement controller (levels: first, last, default)
(c) subject-predicate order (levels: preverbal subject, postverbal subject),
(d) type of coordination (two levels: collective, for which we used conjunction in an affirmative context and conjunction in a negative context, and non-collective, where we used negative concord conjunction in a negative context and disjunction).

We here include the type of coordination as a variable, because it is a potential source of variation, which we carefully treated in our analysis (we analyzing other variables separately within each level of this variable, and report them for only one level of this variable), but which is not targeted by

the analysis. Regarding Exp1, we focus on the data within the level disjunction, as it is the level with the smallest difference between the levels of the crossed variables of agreement controller and of the subject-predicate order. The tendencies within other levels are the same (there was no interaction between animacy and this variable), and hence the choice of level of type of coordination did not significantly affect the reported results.

All tested stimuli included coordinated subjects with only singular members in the form FSgFSgMSg, i.e. MSgFSgFSg, with the targeted position for SCA always containing a feminine member (because masculine is also the default). In order to maximize the effect of animacy, proper names were coordinated in all animate conditions.

In respect of agreement controllers, number and gender were treated as a bundle, i.e. in items exhibiting first conjunct agreement both number and gender are copied from the first member of coordination (FSg in all our examples), in items representing last conjunct agreement, both features are valued from the last member of coordination (FSg too), and in default, both have the value of the entire coordination (MPl).

A single stimulus, here one that involved default agreement with a preverbal inanimate subject triggering default agreement (condition +AnimDefSV), looked as in (12).[10]

12. Gde da stavim nož, viljušku i kašiku?
    where to put.1Sg knife.MSg fork.FSg and spoon.FSg
    'Where should I put the knife, the fork and the spoon?'

    Nož, viljuška i kašika nisu neophodni.
    knife.MSg fork.FSg and spoon.FSg NegAuxPl necessary.MPl
    'The knife, the fork and the spoon are not necessary.'

Each sentence had a coordinated subject consisting of three singular nouns in a coordinated structure, one masculine and two feminine. The middle member of the coordination was always feminine. In stimuli testing single conjunct agreement, the other feminine noun was placed in the posi-

[10] All context sentences introducing the coordinated expression in order to make it discourse old had this expression in the direct object position to avoid effects of priming, expected if they occurred in the subject position.

tion targeted by the agreement pattern (for the highest conjunct agreement pattern in the first position and for the closest conjunct agreement in the last position preverbally and in the first position postverbally). Two feminine nouns were used in order to balance the default status of the masculine gender of the third member of coordination.

The agreement on the verb was manipulated in such a way that configurations where number and gender necessarily target different constituents were excluded: default gender agreement went with plural number, and gender agreement with a single member of coordination went with singular number (since the single member was singular too). This turned out to be a limitation of the experiment, after Experiment 2 showed the tendency of mixed gender coordinated singulars to trigger number agreement in plural combined with gender agreement with a single member of coordination in production. Further research should cover this caveat.

We computed the effects of all independent variables and their mutual interactions, but in this paper we focus on the level of acceptability of each of the patterns and on the effects and interactions of this variable and the variable of animacy. Hence, we only report here the effects and interactions directly relevant for the theoretical questions targeted.

In this paper, we are interested in how animacy influences the choice of agreement patterns. In other words, we are interested in the variable of animacy and its interaction with the agreement patterns. We have therefore crossed the variables of the type of agreement and of the subject-predicate order into one variable, in order to match the taxonomy postulated for the patterns of agreement in the theoretical syntactic literature such as Corbett (1991, 2002, 2009) and Marušič et al. (2007, 2015), assuming with Corbett and Marušič et al. the following five patterns of agreement: agreement with the highest member (H), with the closest member (C, these first two are only in the preverbal position), with the member which is both highest and closest to the verb (HC), the member which is neither highest nor closest to the verb (LF, for lowest farthest) and default (Def). In our experimental setting, Def is split in two levels, the preverbal and the postverbal Def, i.e. DefSV and DefVS, treated by the theoretical analyses as one and the same pattern. In result, we have the following collapsed 2x6x2 design:

(a) animacy (levels: animate, inanimate, abbreviated as Anim and Inan),

(b) agreement pattern (levels: H, C, HC, LF, DefSV, DefVS),

(c) type of coordination (levels: collective, non-collective, i.e. +Coll, -Coll, with the former including conjunction in an affirmative context and conjunction in a negative context and the latter negative concord conjunction in a negative context and disjunction).

As obvious from the design and the number of stimuli, we included only four items per condition in order to reduce the effect of fatigue, and included a high number of participants (nearly 100, with 69 included in the analyzed data) to keep the number of observations sufficiently high.

A list of examples for each condition is provided in (13). To simplify the picture, and because we report the results for disjunction only, we also only illustrate the conditions based on the variables of animacy and agreement type, with the variable type of coordination flattened to its level disjunction.

13. Examples for each of the conditions

+AnimH	Zašto nema svetla u prostoriji? why Neg.has light in room 'Why is there no light in the room?' 'Maja, Jasmina ili Zoran nije kupila novu sijalicu. M.FSg J.FSg or Z.MSg NegAuxSg bought.FSg new lightbulb'
+AnimC	Još nemamo prvi rad? still Neg.have.1Pl 1st paper ''We don't have the first paper yet?' Goran, Milena ili Maja ti je odavno poslala rad. MFSg MFSg or GMSg you.Dat AuxSg long_time_ago sent.FSg sent paper 'Goran, Milena or Maja sent you the paper a long time ago'
+AnimDefSV	Šta treba doneti za proslavu? what should bring.Inf for celebration 'What should be brought for the celebration?' Jasna, Ceca ili Dejan su naručili sve što treba. J.FSg C.FSg or D.MSg AuxPl ordered.MPl all Comp need 'Jasna, Ceca or Dejan ordered all that's needed.'

+AnimHC	Treba li da pokupim to pismo? should Q Comp pick_up.1Sg that letter 'Should I pick up that letter?' Poslala je Marija, Vesna ili Dragan sve na kućnu adresu. sent.FSg AuxSg M.FSg V.FSg or D.MSg all on home address 'Marija, Vesna or Dragan sent it all to the home address.'
	Jel ovo ista ona smesa? is.Q this same that mixture 'Is this the same mixture?' Dodala je Lazar, Jovana ili Jana neke nove sastojke. added.FSg AuxSg L.MSg J.FSg or J.FSg some new ingredients 'Lazar, Jovana or Jana added some new ingredients.'
+AnimDefVS	Nisam dobio nijednu čestitku. NegAux1Sg received.MSg no greetings_card 'I haven't received a single card.' Poslali su ti Ivona, Maja ili Ivan čestitku još prvog dana odmora. sent.MPl I.FSg M.FSg or Ivan.MSg greetings_card already first day vacation 'Ivona, Maja or Ivan sent you a card already the first day of vacation.'
-AnimH	Šta treba doneti za proslavu? what should.3Sg bring for celebration 'What to bring for the celebration?' Pita, torta ili kolač je naručena, kupi nešto drugo. pie.FSg tart.MSg or cake.MSg AuxSg ordered.FSg, buy.2Sg something else 'A/the pie, a/the tart or a/the cake were ordered, buy something else.'
-AnimC	Iz čega se sastoji program? from what.GenSg Refl consist.3Sg program 'What is the program going to include?' Pesma, predstava ili recital je već spreman, videćemo za ostalo. poem.FSg play.FSg or recital.MSg AuxSg already ready.MSg, see.1PlFut for rest 'The poem, the play or the recital are already prepared, we'll see about the rest.'

	Gde ostavljate pribor? where keep.2Pl cutlery 'Where do you keep the cutlery?'
-AnimDefSV	Čaša, viljuška ili tanjir su smešteni na donjoj polici, ostalo je u fioci. glass.Fsg fork.FSg or plate.MSg AuxPl kept.MPl on bottom shelf, rest is in drawer 'The glass, the fork or the plate are on the bottom shelf, the rest's in the drawer.'
	Šta se u nalazi u onoj fascikli? what Refl find.3Sg in that folder 'What's in that folder?'
-AnimHC	Tamo je stavljena prijava, molba ili zahtev. there AuxSg placed.FSg charge.FSg pledge.FSg or application.MSg 'The charge, the pledge or the application has been placed there.'
	Gde je nakit koji je jutros bio ovde? where AuxSg jewelry which AuxSg morning AuxMSg here 'Where is the jewelry that was here this morning?'
-AnimLF	Ostavljen je narukvica, ogrlica ili prsten ispod kutije. left.MSg AuxSg bracelet.FSg necklace.FSg or ring.MSg below box 'The bracelet, the necklace or the ring was left under the box.'
	Od čega je napravljena narukvica? of what.GenSg AuxSg made.FSg bracelet 'What's this bracelet made of?'
-AnimDefSV	Korišćeni su plastika, perla ili biser. used.MPl AuxPl plastic.FSg bead.FSg or pearl.MSg 'Plastic, bead or pearl were used.'

4.2 Results and discussion

As already briefly introduced, animacy showed a general degrading effect over the entire data set. However, this effect was not equally strong across the different patterns of agreement – an interaction is attested where animacy had a stronger effect within the levels HC and C of the variable of

pattern of agreement, weaker effect within levels Def and H, and almost no effect within the level LF.

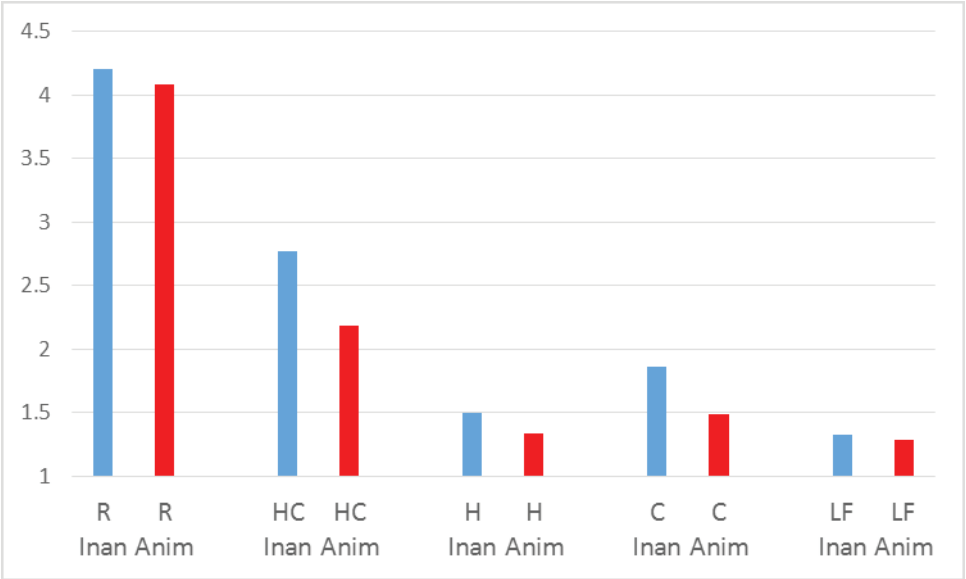

Figure 1

In the aggregate data, the pattern of agreement figured as a significant factor. Default agreement (Def, we grouped the two levels of Def, Def_{SV} and Def_{VS}, in presenting the data due to their nearly identical behavior, and their being treated as one pattern in the relevant literature) was judged as by far the best pattern, with an average grade of 4.15 – which complies with the empirical reports in the literature that with singular conjuncts only Default is available. However, the Highest-Closest pattern (HC) ranked relatively high, with an average at 2.543. Other single member of coordination patterns rank lower, with Closest at (C) 1.742, Highest (H) at 1.412 and Lowest-Farthest (LF) at 1.332. While its average grade indicates that H is very similar to LF, and as basically unacceptable, which supports the views in Bošković (2014), Franks and Willer-Gold (2014), contra Puškar and Murphy (2015), the fact that H is still significantly better than LF ($p<0.007$)[11]

[11] In order to test the significance of the differences, we have applied three different statistical models to our data: (one- and two-way) Anova, Mixed Effects Model (MEM)

and the interaction of pattern of agreement with animacy with respect to H ($p<0.009$ for Anim vs. Inan within H), absent regarding LF ($p=0.31$), as outlined below, suggests that H is a strategy of agreement, though strongly dispreferred one, in support of Puškar and Murphy (2015) and against Bošković (2014) and Franks and Willer-Gold (2014). Note that the implications for the referred papers are quite indirect, taking into consideration that the referred work unanimously disregards SCA with singular members of coordination, and extends their generalizations to coordinated plurals only. As it was not the focus of our research, we do not dwell any further on the effects of the pattern of agreement.

Animacy shows a general degrading effect on the acceptability of examples involving agreement with coordinated subjects, as inanimate items rank better than animate on the aggregate data set (average grades are 2.411 for animate and 2.718 for inanimate, $p<<0.0001$) and within each pattern of agreement. The latter, however, is not always with a statistically significant difference. A statistically significant interaction was attested with the pattern of agreement, with a much stronger effect in C and in HC ($p<<0.0001$ for both), somewhat weaker in H ($p<0.005$), marginally significant in Def ($p<0.017$, on a relatively large sample) and it was not significant in LF ($p<0.561$). In both Def and LF, ceiling and floor effects, respectively, probably played a role.

The results clearly confirm that animacy plays an important role in agreement with coordinated subjects, and as effects are only expected in legitimate strategies of agreement, in those that do get a parse and a semantic interpretation – it supports the view in which of all the patterns, only LF is really rejected as incomputable. Regarding the predictions of the different approaches to agreement, the sharp difference in the strength of effects between C and HC on the one hand, and H and Def on the other falsify the

and Kruskal-Wallis test (KW). All three analyses converged on the statistical significance of the observed effects and interactions. We only report the K-W figures, which have been argued to be most reliable for Likert scale based experimental data due to the nonparametric nature of the test (e.g. Lantz 2013, Jamieson 2004, Agresti 2002, but see also Gibson, Piantadosi & Fedorenko 2011, Norman 2010 a.o. who favor MEM, and e.g. Glass 1972, Lubke & Muthen 2004 arguing for the adequacy of ANOVA). As all the effects reported reach a high level of significance ($\alpha=0.0001$ for all p values reported except for one which we counted as a border level), the choice of analysis does not play a significant role with respect to the reliability of the reported results.

predictions of approaches treating all the patterns of agreement as derived by the same, syntactic, mechanism (Bošković 2009, 2010, Puškar & Murhy 2015), and support accounts predicting their different behavior (Marušič et al. 2007, 2015, Arsenijević 2015a). Similarly, the results are more in line with the Marking and Morphing model of processing (see Mirković & MacDonald 2013 for SC), which distinguishes between two phases in the processing of agreement, one which is more accessible to the conceptual, semantic computations, and another which is more formally syntactic, than with those in which all the patterns compete at the same level. Assuming that agreement may be result of a balanced participation of both marking and morphing (Def and H as the strategies feeding information to the logical form), or of a much stronger involvement of morphing (C as a rather morpho-phonological strategy), it is expected that animacy has a stronger degrading effect on the expressions produced in the latter way. The reasoning is that while animacy indicates the interpretive relevance of gender, expressions with a weak or null contribution in the phase of morphing fail to provide the conceptual information in the relevant domain. As C is more acceptable than H, HC is more likely to be interpreted as C than as H, and hence HC patterns with C. In particular, the special behavior of the LF pattern, its lack of sensitivity to animacy, presents a problem for the competition accounts, which, without further measures, predict a uniform behavior of all the candidate patterns of agreement.

Misidentification accounts may account for the stronger degradation of C and HC under animacy by taking C to generally result from misidentification, perhaps as a strong attraction effect. However, such a view would then predict for HC to be rescued by resorting to an interpretation in terms of H.

4.3 Experiment 2

Experiment 2 (Exp2) was a self-paced production experiment in SC, conducted using the IBEX online platform, via the portal Ibex Farm.[12] We used the experimental design developed by Willer Gold et al. (2015), in which the participant first reads out loud a model sentence displayed on

[12] We express our gratitude to the administrators of Ibex Farm, in particular to its author Alex Drummond, for making our work considerably simpler.

the screen, involving a masculine singular non-coordinated subject (default, with a zero ending), see (14a), and then needs to pronounce the sentence again, but with a substitute conjoined subject involving plural conjuncts provided on the screen (the screen displays the substitute subject as in (14b)).

14. a. Model sentence: Dogovor nije bio prekršen.
deal.MSg NegAuxSg was.MSg violated.MSg
'The deal was not violated.'

b. Substitute subject: zakletve ili obećanja
oath.FPl or promise.NPl

Exp2 was a self-paced production task in which participants were given the instruction to read out loud the model sentence appearing on the screen. Next, participants see a substitute subject involving a combination of F and N. The participants were instructed to pronounce the model sentence with the substitute subject, and then a blank screen is projected, after which they proceed to the following item. Between each two steps, the participant presses the key to skip to the next step. Before starting the experiment, participants are taken through six practice examples, and then there were 38 critical items given in a pseudorandomized order. The experiment was conducted in a quiet room, the materials obtained were recorded using the Audacity software and coded for the featues found on the lexical verb. For the purpose of the analysis, number features were kept as Sg and Pl (as all members of the coordination shared the value of number, we could not identify a single member as the controller), while gender features were, like in Exp1, coded as H, C, HC, LF, Def_{VS} and Def_{SV}, in order to be compatible with the theoretical models of agreement (and with Exp1). For this reason, rather than including the independent variable of the ordering between the subject and the verb, we treated the experiment as two separate sub-experiments, one with preverbal subjects (Exp2a, possible values for the dependent variable: C, H, Def_{SV}) and one with postverbal subjects (Exp2b, values HC, LF and Def_{VS}). The dependent variable across Exp2 was the agreement pattern produced by the participants, with a 2x2 factorial design in each sub-experiment, encompassing the following predictor variables:

1) agentivity (two levels, agentive and non-agentive),
2) type of coordination (two levels, conjunction and disjunction).[13]

The experiment included 32 stimuli and 10 fillers (16+5 in Exp2a and 16+5 in Exp2b, symmetrically distributed). Results cover 38 subjects, 17 male and 21 female, all native speakers of SC, non-linguists in the early twenties from South Serbia, without explicit linguistic education in the past five years (in order to prevent potential prescriptive influences).

As we only report on the results for the conditions involving disjunction, we also only provide illustrations for those conditions which are given in (15) for Exp2a (SV) and in (16) for Exp2b (VS).

15. Illustration examples for each condition, Exp2a

+AgDisj Šampanjac ga je dokusurio. rakije ili vina
champagne.MSg AuxSg him AuxSg finished_off.MSg spirit.FPl or wine.NPl
'The champagne finished him off.' 'spirits or wines'

-AgDisj Alat je kupljen novcem sumnjivog porekla. mašine ili vozila
tool.MSg was bought.MSg money suspicious origin machine.FPl or vehicle.NPl
'The tool-set was bought with suspicious money.' 'machines or vehicles'

16. Illustration examples for each condition, Exp2b

+AgDisj Kasu je napunio porez. takse ili osiguranja
treasury.Dat Aux.Sg filled.MSg tax.MSg fee.FPl or insurance.NPl

[13] As plain conjunction in negative contexts turned out in Exp1 to behave just like conjunction in affirmative contexts, and negative concord conjunction patterned with disjunction, we decided to simplify the design and keep only the unmarked affirmative contexts, with one level of the variable, conjunction, allowing for collective interpretations, and the other, disjunction, excluding them.

'The treasury was filled by tax.' 'fees or insurances'

-AgDisj Najteže mu je padao početak. večeri ili jutra
hardest him AuxSg fallen.MSg beginning.MSg evening.FPl or morning.NPl
'The beginning was the most difficult to him.' 'evenings or mornings'

The null hypothesis was that the instances of the different patterns of agreement will occur with the same relative frequencies across the different (combinations of) values of the independent variables, i.e. that no asymmetry will be observed between agentive and non-agentive stimuli.

4.4 Results and discussion

In this paper, we are interested in agentivity as a predictor of the choice of the agreement pattern. More precisely, since in all the stimuli, all members of the coordination share the same value for number, we are interested in the choice of the agreement pattern in gender, and this is the variable that we focus on. This variable showed no significant interaction with the type of coordination and since the issue of type of coordination is of no interest for the present paper, we ignore it and only report the data for the disjunction.

Numbers of produced items with each of the patterns of agreement for agentive and non-agentive conjoined subjects are given in Figure 2, for Exp2a with preverbal subjects, and in Figure 3 for Exp2b, with postverbal subjects.

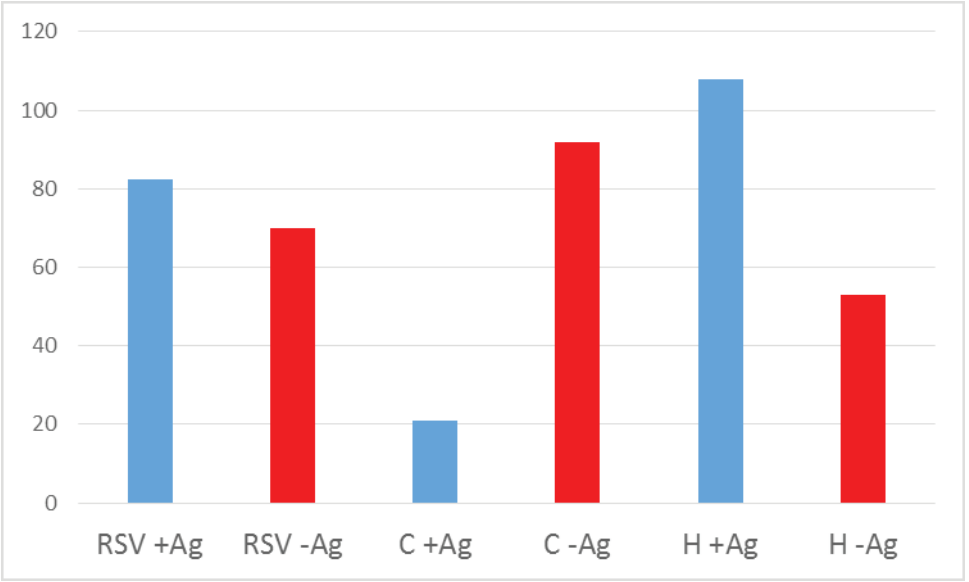

Figure 2: Results of Exp2a (preverbal subjects)

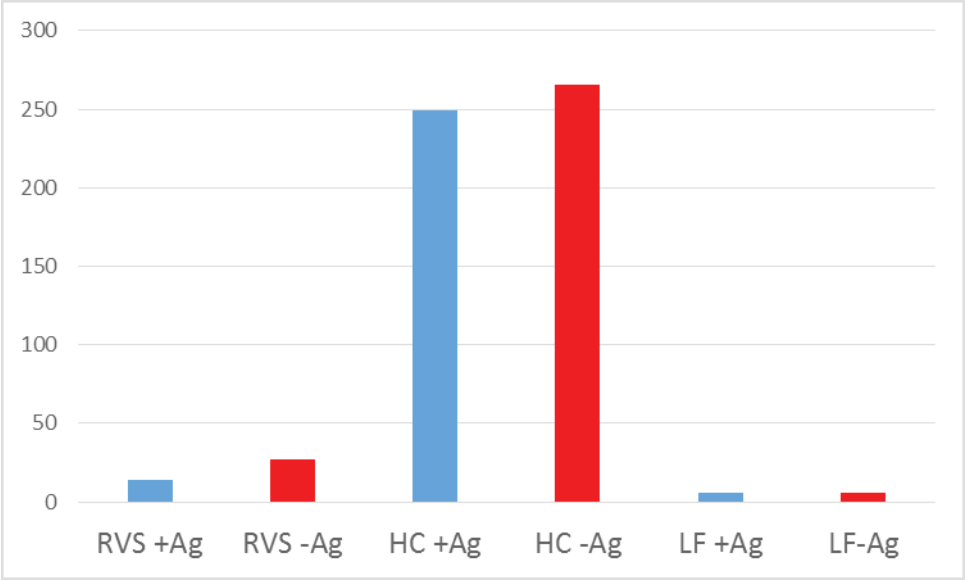

Figure 3: Results of Exp2b (postverbal subjects)

In Exp2a, agentivity plays a significant role within the patterns C (it is more likely for C to be produced under -Ag than under +Ag, $p<0.0001$, with $\chi^2=74.03$ on 6 degrees of freedom) and H (with the opposite direction, it is more likely for H to be produced under +Ag than under -Ag, $p<0.0001$). In Def, the difference is far from statistical significance.[14]

Note also that the aggregate number of the produced H pattern is higher than that of C, and nearly as high as Def, confirming that H is a legitimate strategy, thus supporting the empirical report in Puškar and Murphy (2015) and falsifying that in Bošković (2009).

In Exp2b, there was no statistically significant effect of agentivity. Although Def is produced in -Ag twice as frequently as in +Ag, the difference is not statistically significant, probably due to a low overall number of produced instances of Def. The numbers of produced HC and LF in +Ag and in -Ag are almost identical and far from statistical significance.

Effects of agentivity differ from those of animacy. While animacy in Exp1 showed a general degrading effect on all patterns of agreement, to the highest extent with respect to C and HC, agentivity has a degrading effect on C, no effect on HC, while it has a facilitating effect on H. These differences speak against deriving the effect of agentivity from its link with animacy, and rather suggests that they should be attributed to an independent role which agentivity plays in agreement. This independent role plausibly comes from the fact that agentivity implies a strong vP, and vP is the locus of agreement of the participle with the subject (contra Puškar and Murphy's claim that vP is not involved in agreement in SC, while it is in Hindi).

Observe further that agentivity improves H, considered unanimously by all analyses in the literature to be a result of syntactic computations, while it degrades C, a pattern argued by Marušič et al (2007, 2015) and Arsenijević (2015a), a.o. to be the result of computations at the interface of

[14] We applied two strategies in analyzing the data. In one, we implemented the Multinomial Logistic Regression (MLR) analysis on the entire data set, with agentivity as the independent and pattern of agreement as the dependent variable. In the other, we implemented MEM, Anova and KW separately within each level of the dependent variable, each time coding the analyzed level as 1 and all other levels as 0. In this way, we analyzed the probabilities that exactly that value be produced depending on the value of agentivity. Even though the contrasts significantly differ between the two approaches to the analysis, the results were converging for each level of the dependent variable. We report the results of the MLR test.

syntax with phonology. This is indeed exactly what we expect if the effect of agentivity is mediated by vP, i.e. by a requirement of the strong vP that the verb agrees with the subject in syntax. No effect is observed in HC, as predicted by the analysis in terms of a null pronoun, which postulates a competition between FCA and LCA preverbally (yielding H and C, respectively), but no competition postverbally, where both surface as HC.

In combination, the results of Exp1 and Exp2 presented particularly strongly support the analysis in Arsenijević (2015a), on which Def is insensitive to syntax and sensitive to semantics, H is fully syntactic, and C occurs at the interface between syntax and phonology. Indeed, Def and H, which both imply that information is provided from syntax to LF, are only mildly better with inanimate than with animate subjects. C, which respects phonological locality, and HC (which is ambiguous between H and C) in the more likely case that it is interpreted as C, both imply unspecified gender and number at LF. As expected, they improve significantly with inanimate subjects, i.e. under a lesser semantic prominence. While they are similar regarding the specification of features at LF, Def and H differ in syntax: Def is not competed by other strategies, as it is the result of an inflected pronoun which triggers agreement on the verb, while H competes with C in cases where the pronoun is absent and the entire conjunction is undspecified for gender. Thus, H is more likely to take place if there is a syntactic requirement that agreement takes place in syntax. Agentivity is shown to be one possible trigger of such a requirement, as it corresponds to a strong feature in the projection in which the lexical verb agrees with the subject. In other words, for a lexical input that lacks the specification of gender, agentivity strongly prefers agreement in syntax (H) to unspecified output which gets valued at PF (C). Agentivity has no effect on HC, due to its ambiguity (with agentive verbs, it corresponds to H and with non-agentive verbs to C).

Our results also support the Marking and Morphing approach to the processing of agreement, in confirming a division between the rather formal syntactic component (the one yielding H), and one which is insensitive to syntax (Def). The question remains though whether the patterns which more likely involve phonological computations require a separate, third phase in the model of processing of agreement, or whether they belong to the morphological component within the phase of morphing.

5. Conclusion

We reported on two experiments, one involving acceptability judgments and the other production, focused on the effects of animacy and agentivity, respectively, on the choice of the pattern of agreement in clauses with coordinated subjects. We found that animacy has a general degrading effect on such expressions, which is very strong in agreement patterns involving agreement with the closest member of coordination, and weaker in expressions involving agreement with the highest member of coordination and default agreement. Only agreement with the member of coordination which is both lowest and farthest away from the subject was in no way affected. Agentivity shows a somewhat different effect, as it decreases the number of produced instances of agreement with the linearly closest member of coordination, but increases the number of produced expressions involving agreement with the highest member of coordination, with no significant effect on other patterns of agreement. We take these results to indicate that the effect of agentivity does not fully derive from its link with animacy, but rather comes from the fact that agentivity is syntactically represented in the same projection in which the agreement with the participle takes place (vP). The results support the family of approaches in which agreement with the linearly closest member of coordination is one of the available strategies, and in which it takes place at the interface between syntax and phonology, unlike the other patterns of agreement, which take place before the spell out to PF. Moreover, the results lead to the conclusion that what is labeled default agreement indeed involves features which are present already in syntax, but they do not come from the conjuncts via a syntactically driven copying, i.e. they do not compete with the phonological agreement (C). In a similar way, the results reported support a view of processing of agreement which separates a phase in which lexical and semantic information is accessible, and another one in which it is not, and which, in agreement, is rather responsible for the morpho-syntactic make-up of the agreeing verb.

The research is still at the pilot level, and needs to be complemented by additional investigations, including aacceptability judgment based research of agentivity and a production experiment on animacy, in order to gain the full picture, and to control for the possible differences between judgments and production (i.e. comprehension and production) with respect to the investigated variables. We plan to address these issues in our future research.

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DISTRIBUTIVITY AND AGREEMENT MISMATCHES IN SERBIAN

Abstract: This paper presents a truth value judgment study done on two types of numerals in the Serbian numerical system and corresponding verbal agreement mismatch that is characteristic for the numerals in question. Recent work on agreement and distributivity suggests that singular verbal marking promotes distributivity while plural marking can be interpreted as both distributive and collective. Serbian informants showed opposite intuitions – singular suggests collectivity and plural marking denotes distributivity. Given the highly inflectional nature of the Serbian language, we were interested in investigating to what degree verbal agreement influence interpretation preferences. Two types of numerals – paucal and mixed-gender – were used with singular and plural verbal agreement. Adults and 7-year-old children showed no correlation between verbal agreement and collective/distributive interpretations. Adults accept collective readings and disprefer distributive ones, while children accepted both distributive and collective readings for all sentence forms, even at age seven. We propose a follow up study that will take cognitive load into account and test whether increased load can cause this drastic difference between adults and children.

Keywords: distributivity, collective, agreement mismatch, numerals, verbal agreement, truth value judgment, paucal, mixed-gender, cognitive load

1. Introduction

Syntax and formal semantics have been dealing with the notions distributivity and collectivity for decades. At the same time, developmental psycholinguistics has focused on how children comprehend quantifiers and numerals, given that this is one of the main areas of non-adult behavior (Brooks & Braine, 1996; Drozd et al. in prep; Syrett & Musolino, 2013). Considering numerical quantifiers, for instance, in sentences with two numerically quantified NPs like “Three clowns are holding a present”, two

prominent interpretations are collective (Fig 1.a) and distributive (Fig 1.b) (Musolino, 2009):

Figure 1.a: Collective

Figure 1.b: Distributive

Crosslinguistically, it has been shown that English adults and children differ greatly from Serbian adults and children in Truth Value Judgment experiments with numerically quantified sentences (Knežević, 2012; Knežević, 2015). English adults accepted both interpretations, preferring collective pictures, while Serbian adults rejected distributive pictures. Results from children show that five-year old English children behaved like adults at this age. However, Serbian children differed from Serbian adults and English participants (Musolino, 2009; Knežević, 2012) in accepting distributive readings, and rejecting collective readings about half the time. The percentage of YES-responses of numerically quantified sentences without overt distributive markers (e.g. "Three boys are holding two balloons") is presented in Figure 2.

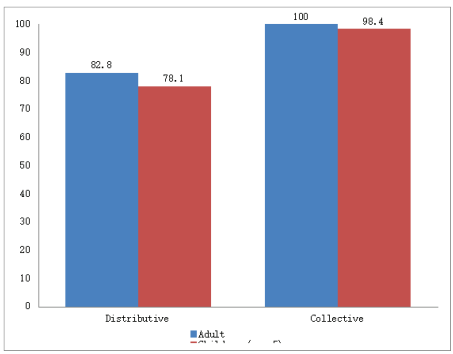


Figure 2.a: Percentage of YES responses (Musolino, 2009)

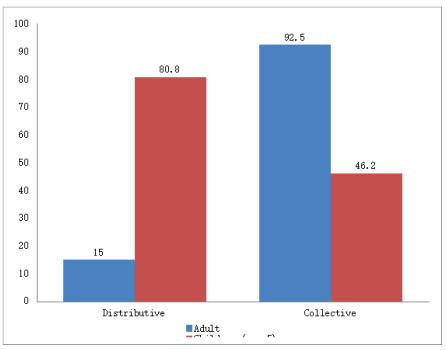


Figure 2.b: Percentage of YES responses (Knežević, 2012)

Recent research suggests that Serbian children are not sensitive to distributive markers until the late age of 8 or 9 (Knežević, 2015), which makes the results in Figure 2.b unexpected because children prefer distributivity. On the other hand, their English speaking counterparts, readily accept both interpretations. We are interested in explaining why is it the case that children consistently choose distributive reading in the period when they have not completely acquired distributive markers.

One of the most obvious differences between Serbian and English is that Serbian is highly inflected. Serbian has several types of numerals which trigger either singular or plural verb agreement in environments with numerically quantified expressions. This difference may account for the disparity in English and Serbian child and adult results. In particular, does subject-verb agreement play a role in the development of the interpretation of distributivity in Serbian children? Therefore, our aim is to look closely into the morpho-syntax of Serbian to uncover cues and markers children and adults are sensitive to and which ones dictate the preference or rejection of certain interpretations.

In the following Section we introduce the properties of Serbian morpho-syntax relating to numerals and subject-verb agreement. Then we explain our predictions as to how this might influence distributivity interpretations in Section 3. In Section 4 we present our experiments, methods and results with Serbian adults and children. Section 5 includes the discussion about the results and the lack of correlation between verbal agreement and distributive/collective preferences, focusing on scalar implicatures as a possible explanation. We make conclusions in the Section 6 and make suggestions for further research, including proposing testing the effect of cognitive load in adults cognitive unload in children on interpretational preferences.

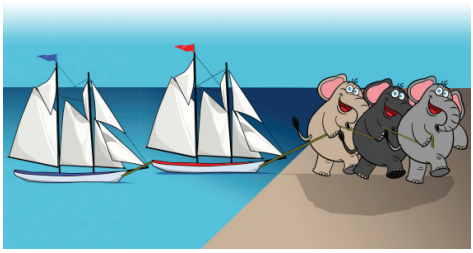
2. Theoretical Background

2.1. Numerical quantification

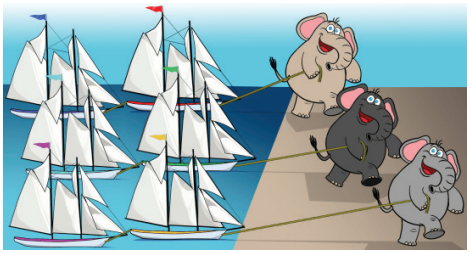
Work on numerals reveals an intricate system of possible interpretations. Musolino (2009) argues there are at least four possible interpretations of a sentence with two numerically quantified NPs and mixed type of predi-

cate,[1] but only two are relevant for the current work. The basic distinction is the scopal relation between these NPs. These two relations, one scopal and one non-scopal, can be illustrated as follows (1):

(1) Three elephants are pulling two boats.



3.a. Collective (Non-scopal)



3.b. Distributive (Scopal)

Scopal relations have to do with which NP (subject or object) takes scope over the other:

Distributive: Subject NP *elephants* takes scope over the object NP *boats*. That means that the Subject NP is a fixed expression, *three elephants*, and it requires the object NP to be distributed over each individual in the set of elephants (known as Subject-wide scope readings). The Object NP is therefore what is being distributed, in this case *two boats*. The interpretation becomes distributive and that entails a total of three elephants who are pulling two boats each, with a total of six boats (3.a)

[1] Researchers also distinguish purely distributive and purely collective predicates (verbs). Distributive predicates (*sing, wave, clap, sleep*) can be modified by distributive markers, or they can be split into individual members of the set. Collective predicates (*gather, meet, share*) cannot be modified by distributive markers and must have plural definites. In other words, if a predicate P refers to every x from a set X, then P necessarily applies to X (it is distributive). However, if P refers to X as a whole set, it does not necessarily apply to every x from X (it is collective). (Champollion, 2014; Stanojević & Ašić, 2006):

1) The women waved =>Every woman waved/ A woman waved. – distributive predicate
2) The women gathered => *Every woman gathered/ *A woman gathered. – collective predicate

The ambiguity, however, comes from the third type of predicate, called mixed predicate. The distinction is not straightforward, and every relation between predicates and the sets or members of the set is possible. Mixed predicates are neither inherently collective, nor inherently distributive.

Non-scopal relations do not depend on NPs taking scope over other NPs, and both NPs are interpreted independently, creating different relations between the members of sets:

Collective: Since both Subject and Object NPs are interpreted individually, each member of the set of *elephants* is connected to all members of the set of *boats* (known as Each-All readings). This interpretation is seen as collective and it entails a total number of three elephants pulling together a total number of two boats (3.b).

Previous research has shown that Serbian adults prefer collectivity when distributive markers[2] are not overtly present in numerically quantified sentences, whereas Serbian children behave non-adult-like by accepting distributivity at a higher rate. On the other hand, in studies with distributive markers (*each* and *every*), English children seem to be insensitive to distributive markers until the age of 5, because they incorrectly accept other interpretations (e.g. cumulative) (Drozd & Van der Lely, 2014). Furthermore, in the case of Serbian, acquisition of the distributive marker *po* is even later, with children accepting collective readings with *po* and preferring distributive interpretations consistently with collective pictures until the age of 8.

So the obvious question arises – why do children choose and prefer distributive interpretation?

In our view, Serbian children may be sensitive to morphological marking before they understand the semantics of overt distributive markers and that is the reason they respond differently than adults. Ouwayda (2014) has suggested that verbal agreement might influence interpretation preferences for distributive and collective readings. Applying this intuition to Serbian, it might be that a plural verb encourages a distributive reading. The motivation for this hypothesis is covered in steps in the following sections.

2.2. Numerals in Serbian

The numerical system of Serbian has been a subject of much syntactic and morphological research because of its complexity of declension and

[2] We use the term "distributive marker" since not all quantifiers are distributive, nor all distributive markers are quantifiers. Different markers are available to force this distributive interpretation – adverbials, inflections, particles, etc. (Gil, 1995). For instance, Serbian has a multi-use morpheme "*po*", Tlingit, an Alaskan endangered language, has the distributive marker "*gaa"* (Cable, 2014) and German has a distance-distributive quantifier "*jeweils"* (Zimmermann, 2002).

agreement properties. Cardinal numerals are classified into several types: (i) basic cardinal numerals, (ii) collective (mixed-gender) numerals, (iii) numerical nouns and (iv) numerical adjectives. Each type comes with specific restrictions and different morpho-syntactic properties due to the type of noun they quantify (Stanojević, 2008). They also express case, gender and verbal agreement mismatches, creating an intricate system that can affect the syntax-semantic interface. However, we will focus only on types (i) and (ii), which are the central part of this paper.

Basic cardinal numerals are numerals like *one, two, three,* but in Serbian (*jedan, dva, tri*) they have different phi-features assigned to them due to the high inflectional nature of the Serbian language. Within basic numerals, 2, 3 and 4 create a closed set of numerals that have completely different forms from the rest. These numerals refer to small quantities, and are said to express so-called "minor plural" or paucal.

Paucal numerals differ from other numerals (1 and 5+) in phi-features and case features of the modifying noun. In English or Dutch, nouns would be in their plural forms when they combine with numerals greater than 2, but not in Serbian. Nouns take a special form, neither singular nor plural, when they are modified (or quantified) by numerals 2, 3 and 4 (2). The noun is said to have a paucal form but it shares some features with genitive singular (Piper et al., 2005).[3] Having this in mind, there is a hypothesis that this apparent singularity of nouns with numerals 2, 3 and 4 yield distributive readings (see section 3):

(2)	a) Jedan one.nom.masc	slon elephant.nom.sg.masc
	b) dva/ tri/ četiri two.nom.masc/ three/ four	slon-**a/***slon-**ova** elephant.pauc.masc/* elephant.gen.pl.masc
	c) pet five	slon-**ova** elephant.gen.pl.masc

[3] Even though this is the case, paucal form cannot be treated the same as genitive for several syntactic and semantic reasons. The most apparent reason is agreement with determiners and adjectives which reveals different inflections for paucals and genitive singular (Belić, 2008).

Collective (mixed-gender) numerals, such as *dvoje* (two), *troje* (three), *četvoro* (four), refer to the number of members in sets which contain individuals of both sexes, hence the term "mixed-gender". To combine with these numerals the modified noun must refer to a group of animate individuals containing both sexes, so it is possible to say *dvoje dece* (two children) or *dvoje studenata* (two students; one has to be a girl and the other has to be a boy), but not **dvoje devojaka* (two girls) or **dvoje stolova* (two tables) (Stanojević, 2008). What is more, mixed-gender numerals can take either singular or plural verb.

2.3. Agreement mismatches in Serbian

The complex numerical system of Serbian may result in Agreement mismatches with other parts of speech. Nouns, adjectives and verbs have to agree in all phi-features (person, number and gender) and case feature.[4] Serbian also distinguishes between natural and grammatical gender. Although the majority of cases agree in all the features and grammatical gender usually coincides with natural gender,[5] there are exceptions, and these are the cases of mismatches.

In this paper, we are focusing on paucal numerals and mixed-gender numerals and instances of verbal agreement that apply to them. Paucal numerals, for example, have both plural agreement and paucal agreement (3).

(3) Tri dečaka su gledala/ ?su gledali film.
three(paucal) boy.pauc is.pl.aux watch.past.pauc/ ?is.pl.aux watch.past.pl.masc movie.acc

[4] Serbian has seven cases (Nominative, Genitive, Dative, Accusative, Vocative, Instrumental and Locative) and three declinations, each with their own inflections and exceptions. The overview and details about Serbian nominal and case system go beyond the scope of this paper.

[5] The book *Many faces of Agreement* (Wechsler & Zlatić, 2003) gives a more detailed syntactic and semantic overview of mismatches in Serbia (one famous example is a mismatch between natural and grammatical gender: diminutive for *girl* can be either *devojčurak* or *devojče*. The natural gender of these nouns is feminine, but *devojčurak* is masculine and *devojče* is neuter.)

Masculine gender agreement in (3), which is the expected semantic agreement due to the masculine feature of *boys*, is marginal in this case, putting syntactic agreement as the default agreement.[6] Furthermore, a verb can also agree with the numeral *tri*. Since the numerals have no gender, it has to be neuter singular and, therefore, the sentence yields singular verbal agreement (4):

(4) Tri dečaka ?je gledalo film.
Three(paucal) boy.pauc ?is.sg.aux watch.past.neut movie.acc
'Three boys were watching a movie.'

Among the three possible verbal agreement options, paucal numerals attract paucal agreement more than semantic agreement or the agreement with the numeral, which is the least common one. All three are, however, available. When it comes to mixed-gender numerals, there are two agreement options – agreement with the numeral and agreement with the NP, both equally available. Consider (5):

(5) Troje Štrumpfova je gledalo/ su gledala film.
three(mixed) Smurf.gen.pl is.sg.aux watch.past.sg.neut/ is.pl.aux watch.past.pl.neut movie.acc
'Three Smurfs were watching a movie.'

While it is expected that the verb agrees with the semantics (quantified expression) and syntax (genitive plural) of the noun, singular verbal agreement (the agreement with the mixed-gender numeral *troje*) is the default agreement (Šarić, 2014). Plural verbal agreement is marked as marginal not because it is border-line grammatical, but because it is less common, which contrasts the pilot study.[7] Mixed-gender numerals usually

[6] In the experiment we used singular and paucal agreement for paucal numerals, given that the paucal agreement behaves as the default one. However, we refer to paucal agreement as plural for simplicity and for the sake of comparison to mixed-gender cases. The fact that we do this does not interfere with our judgements about collectivity and distributivity.

[7] In a pilot study, 106 Serbian adults (mean age: 25;9) were asked to give 5-point Likert scale ratings on the naturalness of sentences with numerically quantified NPs in present tense. The factors tested were the influence of numerals and gender. We used feminine (*devojčica* 'girl',

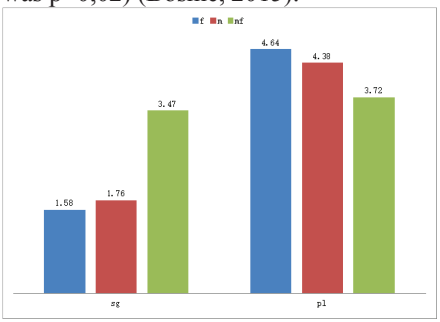
attract collective interpretations[8], hence the term *collective numerals*, and their default verbal agreement is singular. These observations then suggest that verbal agreement might play a role in the interpretation preferences of ambiguous sentences.

Having covered some of the relevant properties of numerical quantification, numerals and agreement, we can proceed with our predictions and hypotheses regarding the interpretations and morphological cues in Serbian that we use in our experiments.

2.4. Morphological markedness

Within synthetic morphology languages there are highly inflectional languages, such as Serbian or Russian for instance, and languages with weaker or simpler inflectional systems, such as English and Dutch. We can also say that the former type has more morphological markedness than the latter. When it comes to language acquisition and its correlation with mor-

devojka 'young-adult girl', *žena* 'woman', *drugarica* 'girl-friend', *sestra* 'sister') and masculine nouns (*dečak* 'boy', *momak* 'young-adult boy', *muškarac* 'man', *drug* 'boy-friend', *brat* 'brother') with basic (paucal) numerals *dva* 'two', *tri* 'three' and *četiri* 'four'. As target items we used mixed-gender nouns (*deca* 'children', *studenti* 'students', *ljudi* 'people', *učenici* 'pupils', *roditelji* 'parents') with mixed-gender numerals *dvoje* 'two', *troje* 'three' and *četvoro* 'four'. Pair tests showed that all potential interactions were significant ($p<0,001$ for all except for f-sg and m-sg, which was $p<0,02$) (Bosnić, 2015):



There is a significant preference of male nouns/plural verbal agreement than for male nouns/singular agreement. More importantly, it is interesting to see that mixed-gender nouns (mf) score is high for both agreements but not at ceiling, suggesting that it is possible that both options are equally possible but it is not formally described.

[8] It is also mentioned in the pilot study by Knežević (2012) that children choose collective pictures more with mixed-gender numerals, and distributive with paucals.

phological markedness crosslinguistically, there are, as expected, discrepancies in the process of acquiring certain highly or weakly marked forms.

Rich morpho-syntactic forms in a language may cause acquisition to go either way. Studies were done investigating the impact of markedness and rich systems across languages which revealed interesting crosslinguistic variation. In an extensive study about Aspect in 12 European languages, it was shown that the meaning of (highly) marked forms (Slavic and Romance languages) is learnt and understood earlier than unmarked forms (Germanic languages, English in particular) (Van Hout et al., in prep). Veerle van Geenhoven (2006) also argued in favor of the view that rich inflectional system contributes to earlier learning "…given that in English inflection often contributes aspect and tense information, we can ask whether English learning children lack the cognitive capacity to deal with time and to understand the ways in which time is integrated into language."

This research suggests that morphology affects acquisition and possibly interpretive skills. Hence we suggest that verbal marking in Serbian could be related to the acquisition of quantification and cognitive skills that its processing involves. Looking at morphologically rich languages (agglutinating or polysynthetic) gives more variables to analyze and more markers to test. Young learners of such languages are exposed to complex morpho-syntactic systems and input at a very young age, which often results in them being sensitive to small and delicate distinctions in languages (Van Geenhoven, 2006).

3. Morpho-syntax and Distributivity

Considering everything mentioned above, we can now make two general predictions on how morpho-syntactic properties might influence preferences for collective and distributive readings: (i) verbal agreement correlates with the distributivity vs. collectivity opposition and (ii) nominal inflections influence interpretation preferences and can disambiguate sentences. Let us first clarify our motivation for these claims.

(i) Existing research on verbal agreement (and distributivity) offers the proposal that singular verb agreement suggests distributivity (Drozd & Van der Lely, 2014) and that singular predicates range

over atoms (Winter, 2002). This claim has also been made about Lebanese Arabic by Ouwayda (2014), who suggested that singular verbal agreement will yield distributive readings, while plural will yield collective readings.[9]

However, there is evidence that plural agreement is triggered when the predicate is distributive (i.e. triggering semantic agreement) (Wechsler, 2009). Moreover, according to studies on agreement production in several languages, more plural verbs were produced for distributive noun phrases (*the label on the bottles*, for instance) than singular verbs (Haskell, 2003). Haskell further states that in "the constraint-satisfaction approach, the distributive sense promotes a plural verb while the collective sense promotes a singular verb, with the contribution of each depending on the relative dominance of the distributive or collective sense". In other words, this proposal claims that singular verbal agreement implies a single action or activity happening at a given time, while plural verbal agreement implies that the same action is performed at the same time by multiple agents. Therefore, a singlar verb form means a single joint action performed by all the members of the group designated by the subject.

(ii) Also relevant is Knežević's (2012) explanation that the difference between Serbian and English speakers in Figure 2 relates to the notion of singularity. So far we have shown that paucal numerals modify the noun which then has a paucal number, and which is formally (Piper et al., 2005), but wrongly,[10] seen as singular. Knežević (2012) argues that it could be the noun in its paucal form (that in this case only seems like it is genitive singular) which restricts the interpretation to distributive since singularity could relate to distribution over atomic individuals (Knežević, 2012). In addition, in her pilot study, Knežević tested paucal numerals and mixed-gender numerals and saw a tendency for children to accept distributive pictures with paucals and collective pictures with mixed-gender numerals. That led her to assume that nominal inflection influences this choice – paucal

[9] In the case of Lebanese Arabic, plural agreement is said to yield both collective and distributive reading (Ouwayda, 2014).

[10] Despić (forthcoming) argues that paucal cannot and should not be formally seen as singular because it does not share the same number features as singular, although they are syncretic in form.

form of the noun is attracting distributivity and the plural form of the noun with mixed-gender numerals is attracting collectivity.

The goal of our experiments was to determine which of these hypotheses apply and which cue is prominent in choosing a particular interpretation in numerically quantified sentences. To control for nominal inflections and verbal agreement we had to address one matter in the experiment with paucal numerals. Namely, we wanted to have a clear morphological indicator that the noun modified by the numeral overtly shows its paucal features. The nouns for the experiment were carefully chosen to meet this criterion. This means that the nouns used had a clear and overt morphological form of paucal case distinct from genitive plural case. To illustrate, compare the following examples:

(6) Boy: Nom.sg: 1 dečak Pauc: 2,3,4 dečaka Gen.pl: 5+ dečākā
Dog: Nom.sg: 1 pas Pauc: 2,3,4 psa Gen.pl: 5+ pasa

The paucal and genitive plural forms of the noun *boy* only differ in vowel length. We wanted to avoid that and to explicitly show participants a different morphological form, that is, as already discussed, the same as genitive singular. The purpose of this was to put these nominal inflections against verbal agreement and see which indicator is stronger for a particular interpretation. Let us illustrate how this would work:

(7) Tri psa su vukla kolica.
three.paucal dog.pauc were pull.past.pauc cart.acc
'Three dogs were pulling a cart.'

Here we have conflicting marking – singular-like feature on the noun and plural (paucal) on the verb. Should it be the case that this example yields distributive reading, nominal inflection is a dominant marking to which speakers are more sensitive; if the opposite is true, then the stronger marker is the number feature on the verb.

We designed and conducted two experiments and tested Serbian adults and Serbian children. The method and results are covered in the following section. We did, however, assume that verbal agreement would be a stron-

ger marker for distributivity than nominal inflections, being more striking and prominent than paucal features in the sentences.

4. Agreement experiments

Two Truth Value Judgment task (TVJT) experiments were conducted to test whether verbal agreement has an effect on the choice between the collective and distributive readings of numerically quantified sentences in Serbian. The two experiments differ[11] in the type of the numeral (and therefore, type of noun) used – between paucal (Experiment 1) and mixed-gender numerals (Experiment 2).

Participants:

Experiment 1: 38 Serbian adults (mean age: 26.9) (Experiment 1a) and 25 native Serbian children (12 girls/13 boys; mean age: 7;6) (Experiment 1b).

Experiment 2: 32 Serbian adults (mean age: 25.1) (Experiment 2a) and 24 native Serbian children (11 girls/13 boys; mean age: 7;7) (Experiment 2b).

Adults who declared themselves as linguists and/or bilingual were excluded from the analysis in order not to affect the results with these additional variables.

4.1. Method and Procedure

Both Experiment 1 (a and b) and Experiment 2 (a and b) were TVJTs and had a 2x2 balanced design, with 24 target items and 24 control items, in 4 lists. The participants were asked to determine whether the given sentence

[11] The other noteworthy difference is the tense used for the experiments. Since the naturalness test showed equal acceptance of both singular and plural verb on mixed-gender numerals in present tense, we used present tense in the mixed-gender TVJT. For the paucal TVJT we used past tense, since the preliminary judgements for paucals with singular and plural verb in past tense were not as clear as for the present tense. It is very important to note that past tense is also marked for gender, which is not controlled for in this experiment, but it can have a significant effect of the grammaticality of the sentence. This, however, exceeds the scope of this paper and it will be dealt with in later studies.

accurately described the given picture. The experiments were available online and adult participants completed the experiment independently online.

Children were tested individually with the experimenter present. Each participant took 5-7 minutes to complete the test independently, since they could select responses alone, on a touch-screen laptop. The experimenter gave the following instruction to the children: *"We have a program that mixed up some of the pictures and sounds. We need your help to sort them out. All you need to do is to select YES if you think the combination is correct and NO if you think it is wrong."* Adults had the instructions available on the website, but not in the child-like manner shown above.

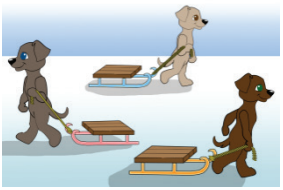
Target items: 4 different verbs and 4 different nouns were used with 24 different objects to create target items. The verbs used were of a mixed type, very typical to these types of studies, with clear relational ambiguity (*carry*, *hold*, *push* and *pull*). The nouns used for Experiment 1 are: *pas* 'dog', *slon* 'elephant', *vanzemaljac* 'alien', *klovn* 'clown',[12] all showing different morphological inflections in paucal and genitive plural case (section 3) (8a).

For Experiment 2 we had to select nouns that are plural, mixed-gender nouns, in order to satisfy the criteria of mixed-gender numerals. The nouns in question were: *deca* 'children', *ljudi* 'people', *Štrumpfovi* 'Smurfs', *vanzemaljci* 'aliens'[13]. In the case of aliens, we used two male and one female alien to justify the mixed gender feature (8b) (See appendix C for a complete list of target sentences).

[12] It is important to note one thing that made this experiment unbalanced was the length of syllables in nouns used. Namely, the fact that one noun is considerably more longer (*vanzemaljac*) that other three (*pas*, *slon* and *klovn*) could have an effect on agreement and possibly cognitive load required to process longer and more demanding nouns (Arsenijević, p.c). However, in our opinion, and given the results, this flaw in the experiment did not affect the core purpose of it – distinguishing between collective and distributive readings. Indeed, it could have had an effect on the agreement preferences, however this issue was not tested here.

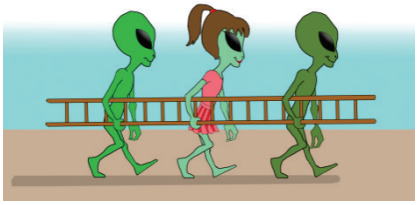
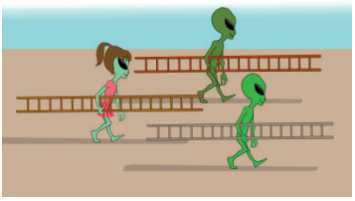
[13] Boban Arsenijević (p.c. 2016) points out specific features of certain mixed-gender nouns chosen for this experiment: the problem emerges with the noun *deca* 'children' which is not a true mixed-gender noun, because its semantics does not have semantic gender. It is actually a hybrid noun with different properties (syntactically feminine singular and semanticaly plural, and can be compatible with either sex) and without a direct morphological singular, which was also the problem with the noun *ljudi* 'people' (see Alsina & Arsenijević, 2012). These properties could have interfered with the experiment and results for these nouns. Another conflicting issue could have been the number of syllables as it was the case with the paucal experiment.

a)

Tri psa je vuklo/su vukla sanke.
"Three dogs was pulling/were pulling a sledge."
- One combination (out of 4 possible) per participant.

b)

Troje vanzemaljaca nosi/nose merdevine.
"Three aliens is carrying/are carrying a ladder."
- One combination (out of 4 possible) per participant.

Control items: We counterbalanced Experiment 1 and Experiment 2 items with 24 control items. They had a larger number of NO responses to avoid the YES-bias for children. Another purpose these items had was to control if the children were paying attention so they were completely unambiguous, unrelated and clear (8).

(8)

Slon pere žirafu.
"The elephant is washing a giraffe."
- clear NO answer

4.1. Results

Generalized logistic mixed effect models[14] (Baayen et al., 2008) and random slopes were used for analyzing all the results (see Appendix A and B for the complete best final models). We tested the maximal model first in a stepwise fashion. General observations from the models given in Appendices A and B are that adults are significantly less likely to accept distributive pictures matched with either singular or plural verb than children, and less likely to accept singular verbal agreement. Neither experiment showed significant correlations between verbal agreement and collective/distributive interpretations. The results are presented and described in the following sections.

4.1.1. Experiment 1, Paucal numerals – Adults and children

Adult and child responses differ greatly in that adults rejected while children accepted distributive pictures (Figure 3 – YES responses). The paucal experiment revealed that adults are less likely to accept a verb in singular (Est: - 1.154; $p< 0.000$), which is in line with the results from the naturalness study, in which singular verbal agreement is not preferred and it is considered ungrammatical. More strikingly, adults are significantly less likely to choose distributive pictures (Est: -9.521; $p<0.000$), which is not the case with children (Est: 2.677: $p<0.255$). In Experiment 1, we do see that children are have more adult-like responses, since there is a preference for collective pictures. To an extent, this is expected, since they are older children (7-year-olds), and given the child data of three age groups (5-, 7- and 9-year-olds) Knežević (2015) collected for her studies, children slowly and gradually start rejecting distributive pictures (because they are becoming aware of the role of distributive markers). However, when asked, children gave a reason for their rejection of distributive pictures in Experiment 1 – it still had nothing to do with overt distributive markers, but with the singularity of the object (see section 5).

[14] *glmer* function; R version 3.1.2; Copyright © 2014

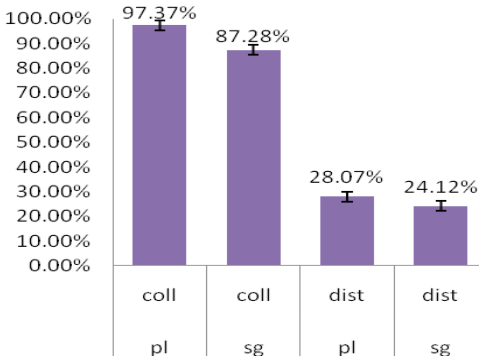


Figure 4.a: Adult results, Paucal

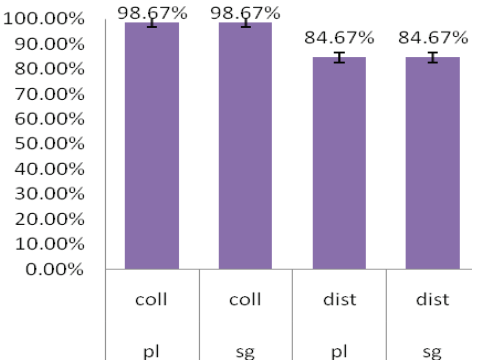


Figure 4.b: Children results, Paucal

4.1.2. Experiment 2, Mixed-gender – Adults and children

The mixed-gender experiment showed a similar comparison between adults and children (Figure 4 – YES responses). However, in the best fitting models for this experiment, verbal agreement was not a significant factor. Adults were still likely to reject singular agreement which is in line with the result from the pilot (i.e. plural verbal agreement is preferred) but not the established theories (i.e. singular verbal agreement is the default agreement for mixed-gender numerals). As expected, adults were significantly more likely to reject distributive pictures in general (Est: -6.86890; $p<0{,}000$) unlike children (Est: 3.9109; $p<0.106$). There are, however, a few notable remarks that are different from Experiment 1. Children almost equally accepted all pictures, proving that this group of children was still not thinking in terms of overt markers or singularity of objects, which will be covered in the Discussion. Second, adults did not reject singular verbal agreement, showing again (congruent to the naturalness study) that both agreements are equally valid, unlike with paucals.

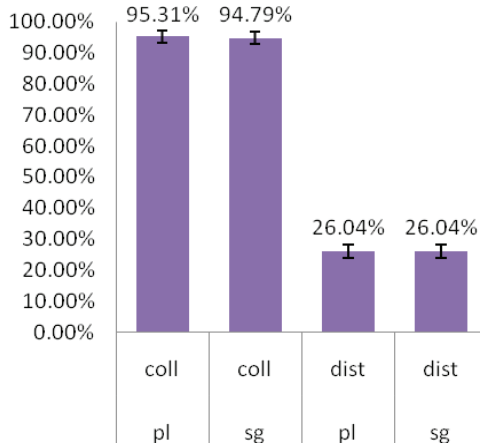


Figure 5.a: Adult results, Mixed-gender

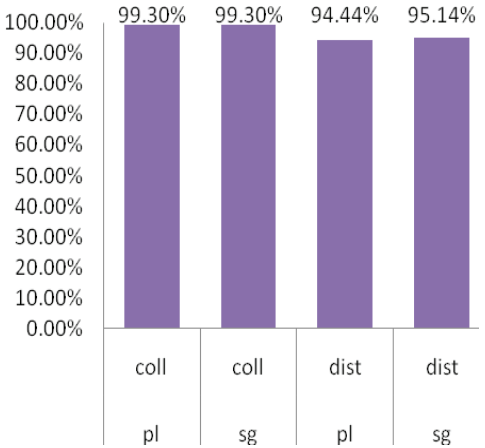


Figure 5.b: Children results, Mixed-gender

5. Discussion

Contrary to our predictions, we saw no sensitivity to verbal agreement with regards to collective/distributive reading – verbal agreement may not be strong enough of a cue to disambiguate sentences. However, it is important to note that answers could be influenced by factors we did not control for, such as world knowledge, discourse and types of predicates.[15]

If we, for example, focus on the Serbian adult results only, we see almost complete rejection of distributive interpretations. English adults would not reject distributivity at such a high rate; for them, numerically quantified sentences are ambiguous, but with a preference towards collectivity (Musolino, 2009; Syrett & Musolino, 2013). For Serbian adults, this is not the case – it looks like distributive interpretation is marginal, if not incorrect. We are still faced with a question of what makes Serbian system so different from English. It is possible that morpho-syntactic marking could, in theory, still play a role, since the current study suffered some design flaws. Different

[15] This is one of the reasons we are planning follow up experiments which will control for these factors and show production data from Serbian adults and children. These will clarify which verbal agreement is truly dominant in adult and child language and whether there are some conditional preferences towards one or another.

experimental designs could be established to further pursue this hypothesis. However, we would have expected at least some indication of an effect, but there was none.

Maybe the Serbian system differs from English because Serbian has different distributive markers available in the language. From previous studies we know that Serbian has distributive quantifiers and distributive markers, such as *po*. Knežević (2015) claims that the marker *po* is a distributive-share marker, while English lacks distributive-share markers. Distributive-share markers modify the element that is distributed, and not the element it is distributed over. The presence of *po* in Serbian, however, may cause Serbian adults to reject distributive pictures because more informative and prominent ways of conveying the distributive reading are available in the language. Having *po* in a sentence blocks collective interpretations and it is then expected that the lack of *po* would block distributive interpretations. An analysis along similar lines has already been proposed in Pagliarini et al. (2012). They argue that definite plural or numerically quantified expressions, which can be ambiguous for collective and distributive reading, can instead be interpreted as strongly collective by adults via a scalar implicature: because there is another, more explicit way of conveying the message with distributive meaning (i.e. marking it with *each*). However, if that marking is not present the speaker must not intend a distributive reading. This proposal thus claims that semantically, both readings are possible, but pragmatic reasoning disambiguates the sentence. This same reasoning could easily account for Serbian as well (9):

(9) a. Tri klovna nose poklon.
three.pauc clown.pauc carry.pl present.sg
'Three clowns are carrying a present' OK collective/ ??distributive

b. Tri klovna nose po poklon.
Three.pauc clown.pauc carry.pl DIST present.sg
'Three clowns are each carrying a present' *collective/ OK distributive

Even though adults judge the distributive reading marginal in (9a), it is still available. *Po*, on the other hand, makes collective interpretation

impossible. A hearer interpreting (9a) may consider the fact that the speaker did not say (9b) as evidence that the collective reading is probably intended. So far, this seems like a good explanation of the results and differences between the speakers of languages with less marking and with more complex marking in morpho-syntax. But what about children and how do we explain their results?

We know that Serbian children prefer distributive readings for sentences without a distributive marker at age 5, as it is evident from the study by Knežević (2012) (Figure 2). Our study, however, shows that they still choose distributive readings at age 7 (Figures 4 and 5) which is when English speaking children have become almost adult-like. If we take the complexity of the system and markedness into account, we should see a more delicate sensitivity to different linguistic markers, and keeping in mind that *po* is highly informative, children should have been able to be sensitive to it. Since this is not the case, it is possible that the problem is with numerous meanings of *po*, and form-to-meaning relation, which is one-to-many in case of *po* (van Hout, 2008). Not only that, we also believe that due to the complexity of the system, children have an increased cognitive load, which results in incorrect responses and late acquisition of certain markers.

This account would predict that manipulating the cognitive load of experimental participants should have an effect on interpretation preference. For example, Van Rij et al. (2009) found that for pronoun processing, slowing down the presentation of experimental stimuli decreases the working memory load for children and caused them to behave more adult-like. The opposite can be done with adults. We can increase their working memory load with additional tasks to see if their performance alters towards being more child-like.

Although this speculation explains some discrepancies in the results, there is one more instance we need to cover. Comments by participants suggest that the singularity of the object in the sentences is the reason for rejecting distributive pictures. Our experiments had a singular object, which we primarily chose to avoid confusion with cases of cumulativity. In addition, singular indefinite objects allow atomic (individual) interpretations, since singularity generally endorses distributivity. Moreover, a few online studies, such as the on-line reading study by Patson and Warren (2010) showed that singular indefinite noun phrases within a distributed predicate can be

interpreted as conceptually plural.[16]A singular indefinite noun X can have wide (one) and narrow (many) scope readings, meaning it can refer to either one X (collective) or many X (distributive) (Perez-Leroux, 2005) (11):

(10) Three girls own a dog.
Wide scope (collective): there is only one dog and it is owned by three girls.
Narrow scope (distributive): there are three dogs and each girl owns one dog.

For both our experiments we expected that children would say YES to all conditions, given the results from previous studies. Whenever a child said NO and showed a more adult-like behavior, the experimenter asked why. The response was always related to the fact the object was in singular and the correct way would be to put it in plural for distributive pictures. We illustrated this instance below (11):

(11)

Troje Štrumpfova nosi ogledalo.
'Three Smurfs are carrying a mirror.'
Child: No, because they are carrying three mirrors.

[16]This study, however, is inconsistent with the eye-tracking study by Paterson et al. (2008), in which they concluded that participants did not interpret singular indefinites as conceptually plural because it took longer to process plural anaphors referring to the indefinite noun phrases. Patson and Warren (2010) do think it has to do with slightly different stimuli – they used shorter sentences with a bias towards the reading where singular indefinite noun phrases fall under the scope of a distributive quantifier, while Paterson et al. (2008) had much longer sentences with full ambiguity.

Only 6 out of 49 children explicitly discussed the indefinite singular object as a reason for rejecting distributive interpretations. We can now say that children did not reject pictures (there were no extra agents or extra objects), but actually sentences, so this cannot be the case of spreading – errors children make when they reject universally quantified sentences because there are additional objects (Brooks & Braine, 1996). What can be concluded is that Serbian children reject distributive pictures with sentences with singular indefinite objects. Singular indefinite noun phrases therefore cannot be interpreted as (conceptually) plural, which is in contrast with known on-line and off-line empirical data. How do we explain this?

There is a view that supports cognitive load for children and conversational implicatures for adults. It is important to note that using the plural form of the object in the target sentences (e.g. Three Smurfs are carrying mirrors.) is far more informative in favor of distributive scenarios than using the singular object, which has to be interpreted as conceptually plural. Thus, a child would prefer rephrasing and simplifying the sentence to get the distributive reading, rather than go through a cognitive process of interpreting singular as conceptually plural to obtain the same effect. On the other hand, there is an alternative explanation: perhaps children do not realize that singular indefinites can be interpreted as plural. This seems highly unlikely, even though we do not have evidence that adults think in a similar fashion, so we cannot claim adults would not reject distributive pictures because of the singularity. Since we know that children are generally bad with scalar and conversational implicatures (Mirić & Arsenijević, 2013) at a younger age, maybe the simplest explanation is that interpreting singular as conceptually plural is no more than a language development stage that children have not yet reached.

6. Conclusion

In this study, we investigated the correlation between verbal agreement and distributivity/collectivity preference in adults and 7-year-old children in Serbian. We did not find any significant effect of verbal agreement (nor nominal inflections) on particular interpretations, thus morpho-syntactic inflections might not be strong markers for distributivity and collectivity,

contrary to what has been proposed in Lebanese Arabic (Ouwayda, 2014). We proposed an alternative explanation in which adults understand numerically quantified sentences without distributive markers as scalar implicatures – since there is a better alternative to convey a distributive message, numerically quantified sentences must be collective. For children, however, we suspect that complex morpho-syntactic system of Serbian loads children's working memory, and it is affects the processing of such ambiguous sentences. Future work should look into the matter of cognitive load, as well as try to rank distributive markers crosslinguistically.

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Appendices

Appendix A

Experiment 1a –Paucal numerals, adults: Fixed effects of the best fitting linear mixed effect model:

Formula:

Answer ~ Agree + Picture + (1 + Picture | Question) + (1 + Picture * Agree | ID)

Fixed effects:

Predictor	Estimate	SE	z value	p-value
(Intercept)	7.698310	0.001507	5110	<0,000
Verb singular	-1.154014	0.001507	-766	<0,000
Distributive picture	-9.521166	0.001507	-6320	<0,000

Experiment 1b – Paucal numerals, children: Fixed effects of the best fitting linear mixed effect model:

Formula:

Answer ~ Agree + Picture + (1 + Picture | ID)

Fixed effects:

Predictor	Estimate	SE	z value	p-value
(Intercept)	4.313	0.5588	7.718	<0,000
Verb singular	-0.000000865	0.4650	0.000	1.000
Distributive picture	2.677	2.350	1.139	0.255

Appendix B

Experiment 2a – Mixed gender numerals, adults: Fixed effects of the best fitting linear mixed effect model:

Formula:

Answer ~ Agree + Picture + (1 + Picture |Question) + (1 + Picture | ID)

Fixed effects:

Predictor	Estimate	SE	z value	p-value
(Intercept)	4.89691	1.08941	4.495	<0.000
Verb singular	-0.02111	0.30307	-0.070	0.944
Distributive picture	-6.86890	1.21018	-5.676	<0,000

Experiment 2b – Mixed gender numerals, children: Fixed effects of the best fitting linear mixed effect model:

Formula:

Answer ~ Agree + Picture + (1 + Picture | ID)

Fixed effects:

Predictor	Estimate	SE	z value	p-value
(Intercept)	4.8420	0.7763	6.237	<0,000
Verb singular	0.2580	0.7210	0.358	0.720
Distributive picture	3.9109	2.4184	1.617	0.106

Appendix C

List of target items:

PAUCAL NUMERALS a – singular verb b – plural verb	MIXED-GENDER NUMERALS a – singular verb b – plural verb
1a. Tri vanzemaljca je nosilo merdevine.	1a. Troje vanzemaljaca nosi merdevine.
1b. Tri vanzemaljca su nosila merdevine.	1b. Troje vanzemaljaca nose merdevine.
2a. Tri klovna je držalo poklon.	2a. Troje dece drži poklon.
2b. Tri klovna su držala poklon.	2b. Troje dece drže poklon.
3a. Tri psa je vuklo sanke.	3a. Troje dece vuče sanke.
3b. Tri psa su vukla sanke.	3b. Troje dece vuku sanke.
4a. Tri slona je guralo kamen.	4a. Troje Štrumpfova gura kamen.
4b. Tri slona su gurala kamen.	4b. Troje Štrumpfova guraju kamen.

5a. Tri vanzemaljca je držalo sto.	5a. Troje vanzemaljaca drži sto.
5b. Tri vanzemaljca su držala sto.	5b. Troje vanzemaljaca drže sto.
6a. Tri klovna je guralo orman.	6a. Troje ljudi gura orman.
6b. Tri klovna su gurala orman.	6b. Troje ljudi guraju orman.
7a. Tri klovna je nosilo kofer.	7a. Troje dece nosi kofer.
7b. Tri klovna su nosila kofer.	7b. Troje dece nose kofer.
8a. Tri slona je držalo granu.	8a. Troje Štrumpfova drži granu.
8b. Tri slona su držala granu.	8b. Troje Štrumpfova drže granu.
9a. Tri vanzemaljca je vuklo prikolicu.	9a. Troje vanzemaljaca vuče prikolicu.
9b. Tri vanzemaljca su vukla prikolicu.	9b. Troje vanzemaljaca vuku prikolicu.
10a. Tri klovna je guralo auto.	10a. Troje ljudi gura auto.
10b. Tri klovna su gurala auto.	10b. Troje ljudi guraju auto.
11a. Tri psa je nosilo korpu sa voćem.	11a. Troje dece nosi korpu sa voćem.
11b. Tri psa su nosila korpu sa voćem.	11b. Troje dece nose korpu sa voćem.
12a. Tri slona je vuklo brod.	12a. Troje ljudi vuče brod.
12b. Tri slona su vukla brod.	12b. Troje ljudi vuku brod.
13a. Tri psa je nosilo automobilsku gumu.	13a. Troje Štrumpfova nosi automobilsku gumu.
13b. Tri psa su nosila automobilsku gumu.	13b. Troje Štrumpfova nose automobilsku gumu.
14a. Tri vanzemaljca je držalo zastavu.	14a. Troje vanzemaljaca drži zastavu.
14b. Tri vanzemaljca su držala zastavu.	14b. Troje vanzemaljaca drže zastavu.
15a. Tri klovna je vuklo autić.	15a. Troje dece vuče autić.
15b. Tri klovna su vukla autić.	15b. Troje dece vuku autić.
16a. Tri psa je guralo kolica za bebe.	16a. Troje dece gura kolica za bebe.
16b. Tri psa su gurala kolica za bebe.	16b. Troje dece guraju kolica za bebe.

17a. Tri slona je držalo lampu.	17a. Troje ljudi drži lampu.
17b. Tri slona su držala lampu.	17b. Troje ljudi drže lampu.
18a. Tri vanzemaljca je guralo stolicu.	18a. Troje vanzemaljaca gura stolicu.
18b. Tri vanzemaljca su gurala stolicu.	18b. Troje vanzemaljaca guraju stolicu.
19a. Tri slona je nosilo stablo.	19a. Troje ljudi nosi stablo.
19b. Tri slona su nosila stablo.	19b. Troje ljudi nose stablo.
20a. Tri psa je držalo kost.	20a. Troje Štrumpfova drži kost.
20b. Tri psa su držala kost.	20b. Troje Štrumpfova drže kost.
21a. Tri slona je vuklo voz.	21a. Troje ljudi vuče voz.
21b. Tri slona su vukla voz.	21b. Troje ljudi vuku voz.
22a. Tri vanzemaljca je guralo kolica.	22a. Troje vanzemaljaca gura kolica.
22b. Tri vanzemaljca su gurala kolica.	22b. Troje vanzemaljaca guraju kolica.
23a. Tri klovna je nosilo ogledalo.	23a. Troje Štrumpfova nosi ogledalo.
23b. Tri klovna su nosila ogledalo.	23b. Troje Štrumpfova nose ogledalo.
24a. Tri psa je vuklo kočiju.	24a. Troje Štrumpfova vuče kočiju.
24b. Tri psa su vukla kočiju.	24b. Troje Štrumpfova vuku kočiju.

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VERB PRODUCTION AT DIFFERENT STAGES OF LANGUAGE ACQUISITION

Abstract: The results of cross-linguistic research into the acquisition of verbs with different argument structure are not conclusive. While some studies present results which support the nativist theory of language acquisition, others show that the acquisition of verbs can be explained within the constructivist, usage-based theory. Current research into the production of verbs contributes to this on-going debate, by examining the order in which different types of verbs are acquired.
The aim of the research was to examine the order in which the verbs with different argument structure are acquired (unergative, unaccusative, anti-causative, transitive and ditransitive verbs). Twelve subjects belonging to different age groups (1;11 - 4;10 months old) were included in this transversal study. The data collection technique was a structured interview. Children were asked to name actions based on visual stimuli such as toys and drawings, which the interviewer presented. Though the sample was small, among-group differences were noted. The results confirm that children who are at a lower stage of speech development have more difficulty producing verbs with a complex argument structure. Children at a lower stage of speech development are most successful in producing verbs which show a subject-agent correspondence. On the other hand, anti-causatives, which are also one-place predicates, are produced at a much later stage (2;7 months in this research). The results show that the order of the acquisition of verbs is the following: transitive, unergative, unaccusative, ditransitive and anti-causative verbs. Importantly, the participants used adequate tense morphology on the verbs from the earliest age, which indicates that they can recognize verbs as members of a coherent syntactic category, different from that of nouns, which supports the nativist approach. It is expected that the results of a larger-scale transversal study with a greater number of participants will confirm these tendencies.

Key words: verb production, argument structure, language acquisition, early development of syntax, nativism.

1. Introductory remarks

The acquisition of the argument structure of verbs within the process of first language acquisition (LA) has raised a lot of interest, because verbs take the central position in a clause. The relationship between an extra-linguistic situation/activity/event and the participants in the given situation/activity/event is transferred to the relationship between the verb and its arguments on the language plane. This transfer provides an insight into the way children express what they learn about the world and tells us a lot about the manner in which they acquire their native language, which is why this topic has been so important in the studies of language acquisition.

The results of cross-linguistic research into the acquisition of verbs with different argument structure are not conclusive. While some studies present results which support the nativist theory of language acquisition (Pinker, 1984, 1989; Gleitman, 1990; Snyder, Hyams & Crisma, 1995; Fisher, 2000, 2002; Fisher & Gleitman, 2002; Lorusso, Caprin & Guasti, 2005; Lee & Naigles, 2005; Costa & Friedmann, 2012), first developed by Chomsky (1975, 1981, 1986), others show that the acquisition of verbs can be explained within the constructivist, usage-based theory (Brain, 1976; MacWhinney, 1978; Bowerman, 1976, 1990; Bates & MacWhinney, 1982; Ninio, 1996, 1999; Lieven, Pine & Baldwin, 1997; Tomasello, 1992, 2000, 2003; Childers & Tomasello, 2001; Lieven, 2008). This paper will present the results of the pilot research into the production of verbs of different syntactic complexity by Serbian-speaking children at an early age and thus try to make a contribution to the on-going nature-nurture debate.

Although the majority of the above mentioned studies were longitudinal studies that used some of the corpora of early child language, such as the CHILDES system (Child Language Data Exchange System) (MacWhinney, 1989) to look for data, this paper will present the results of a transversal study. The main reason for such a choice is the fact that there are only seven available transcripts of Serbian-speaking children in the CHILDES database, which is a small number if one is to look into the differences of the children's linguistic capacity at different stages of LA. Another reason is the way in which the data was obtained for the mentioned corpus, since we were not sure we would find enough occurrences of each verb type we wanted to test in spontaneous parent-children conversations. Moreover, it

would be costly and time-consuming to conduct a longitudinal study with a greater number of participants. For these reasons, we designed an experiment to test children's production of verbs in different age groups.

The aim of the pilot research is to examine the order in which verbs with different argument structure are acquired (unergative, unaccusative, anti-causative, transitive and ditransitive verbs). Following Pinker's (1984, 1989) Canonical Linking Hypothesis, it is expected that transitive verbs are acquired first, followed by the acquisition of intransitive verbs, and that ditransitive and anti-causative verbs are acquired only at later stages of language acquisition, because they are syntactically more complex. If it is shown that children who are at a lower stage of speech development have more difficulty producing verbs with a complex argument structure, either those with an additional argument (transitive verbs) or those which involve a complex syntactic process of derivation from a transitive verb (anti-causative verbs), this will provide support for the nativist approach, which assumes that knowledge about semantic roles is innate and that less complex verbs are acquired first.

Regarding the structure of the paper, section 2 will deal with the theoretical background. First, different types of predicates and their theta-roles will be presented. The fundamental ideas of nativism will be described next, along with the most important experiments conducted in the field. Then, the usage-based account of language acquisition with its crucial ideas and studies will be presented. After the theoretical background, in section 3, a detailed description will be given of the method, the participant profile and the procedure of the pilot test. Section 4 will deal with the analysis of the results obtained, whereas section 5 will provide a discussion of the results and present some of the limitations of the study. Finally, in section 6, I will summarize the main points of the pilot research.

2. Theoretical background

2.1. Predicates and their theta roles

A predicate describes an extra-linguistic situation/activity/event, but it often requires the presence of obligatory arguments. Depending on the number of obligatory arguments, predicates can be divided into 1-place

predicates (require one argument), 2-place predicates (require two arguments) and 3-place predicates (require three arguments). Some predicates do not need arguments at all. These are called 0-place predicates (e.g. the verb 'rain') (Adger, 2002).

Whether a verb takes one, two, three or no arguments depends on the number of thematic-roles (θ-role) that the verb assigns (Chomsky, 1981). Theta-roles express semantic relations between a situation/activity/event (denoted by the verb) and the participants in that situation/activity/event (denoted by the obligatory arguments). For example, the verb 'bark', which denotes the activity of barking, has only one θ-role to assign – the Agent θ-role (the role of initiating the action).

Theta-roles are semantic, but they bear a special relationship to syntax. In her Theta-system, Reinhart (2000, 2002) offers a possible approach to the process of mapping theta-roles to syntactic functions. Every θ-role of the verb has to be assigned to one of the arguments of the verb. Chomsky (1981: 36) defines this relationship as the Theta-Criterion: "Each argument bears one and only one theta-role, and each theta-role is assigned to one and only one constituent". This means that a single argument cannot be assigned two θ-roles. Moreover, the relationship between syntactic arguments and θ-roles is further described by Baker (1988: 46), who states that "identical thematic relationship between predicates and their arguments are represented syntactically by identical structural relationships when items are merged". Baker's hypothesis is known as the Uniformity of Theta Assignment Hypothesis (UTAH). It means that the Theme θ-role, for example, is always merged in the position of the sister of the verb. However, it does not mean that θ-roles always have the same syntactic functions. The Theme θ-role can be both a subject and an object. In the Minimalist Program, this is explained by the derivational character of the computational system (Zwart, 1998). Whereas the operation Merge joins two syntactic objects together, the operation Move, which is another structure building operation, takes an object created by the operation Merge and moves it to another position in the tree (Adger, 2002). In this way, the Theme argument can move from the position inside the VP (object position) to the position of the specifier of TP (subject position).

The sections below present the analysis of the argument structure and related thematic roles of different types of verbs within the minimalist approach.

2.1.1. Intransitive verbs

Intransitive verbs can be divided into two different types, namely unergative and unaccusative verbs (Perlmutter, 1978; Burzio, 1986). Both unergative and unaccusative verbs take only one argument. However, they differ in the assignment of their only theta-role. Moreover, in some languages unergative and unaccusative verbs select different auxiliary verbs (Sorace, 2000; Laws, 2010).

One-place predicates which assign the Agent θ-role (initiating the action) to their only argument are called unergative predicates. In the sentence *The dog barks*, the Agent θ-role is merged as the external argument of v: [TP [vP the dog barks] [VP <V>]]. This argument later moves to the position of the specifier of TP, i.e. the subject position (Adger, 2002). Whatever the motivation for this movement and its technicalities may be, they are beyond the scope of this paper and are not directly relevant for it. For that reason, they will not be further discussed here.

One-place predicates which assign the Theme θ-role (undergoes some change of state or position) to their only argument are called unaccusative predicates. In the sentence *The dog fell* the Theme θ-role is merged as the internal argument of V: [TP [vP fell] [VP <V> the dog]]. This argument later moves to the position of the specifier of TP, i.e. the subject position (Adger, 2002). In this way, both unergative and unaccusative verbs have their arguments moved to the position of the specifier of TP. This results in occupying the same position at the final step of the derivation for the two types of intransitive verbs. However, the original positions of the arguments are different, as exemplified in Figures 1 and 2.

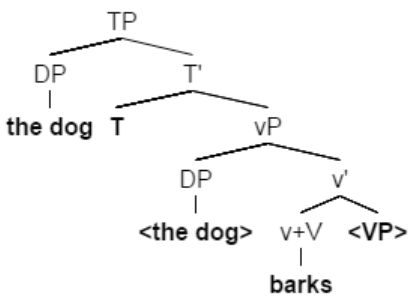

Figure 1 - Tree representation of unergative verbs

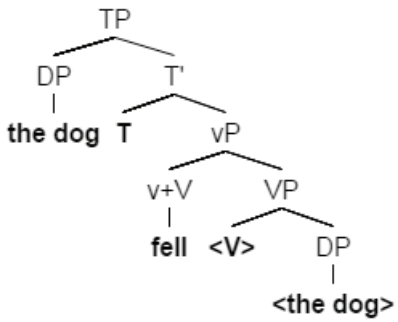

Figure 2 - Tree representation of unaccusative verbs

Unaccusative verbs cannot assign the theme θ-role to their argument. This was formalized by Burzio's Generalization (1986: 178), which states that "if a verb does not assign an external theta-role to its subject, it cannot assign accusative". In other words, a verb which does not assign the Agent θ-role, cannot assign accusative case. Hence, unaccusative verbs cannot assign accusative case. When the argument moves to the position of the specifier of TP, it is assigned nominative case by T.

2.1.2. Transitive verbs

As opposed to unergative and unaccusative verbs, which have either an internal or an external argument, transitive verbs have both. Transitive verbs assign both the Agent and the Theme θ-role. The Agent θ-role is merged as the external argument of v, whereas the Theme θ-role is merged as the internal argument of V (Reinhart, 2000, 2002; Chomsky, 1995; Hale & Keyser, 1993). As shown in Figure 3, the Agent argument moves to the position of the specifier of T. The Theme argument gets licensed by the little v, which assigns it accusative case (under the condition that the verb assigns the Agent θ-role). According to Pinker (1984, 1989), verbs of this type are among the first to be acquired in child language, because they show a canonical linking of semantic roles and syntactic functions (agent-subject and theme-object). This implies that knowledge of thematic roles is innate. Many studies have provided support for this claim (Golinkoff, 1975; Golinkoff & Kerr, 1978; Slobin and Bever, 1982; Pinker et al., 1987; Gropen, Pinker, Hollander, & Goldberg, 1991).

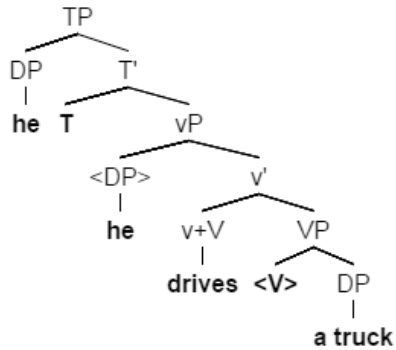

Figure 3 - Tree representation of transitive verbs

2.1.3. Ditransitive verbs

Ditransitive verbs take three obligatory arguments. The analysis of the structure of ditransitive verbs was proposed by Larson (1988). It is widely-known as the VP-shell. Since three slots for the three arguments are needed, Larson's proposal was that two phrases are necessary if binary branching is to be kept. Provided that the subject is in the position of the specifier of the higher phrase, that phrase has to be verbal too. The structure, known as the double-complement construction, is given in Figure 4.

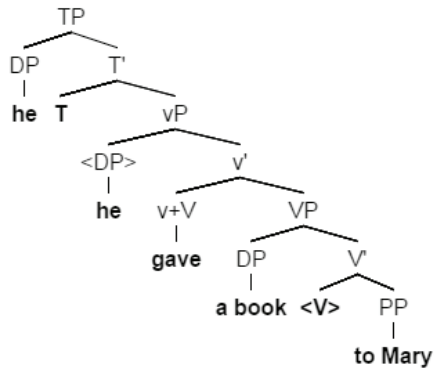

Figure 4 - Tree representation of Agent-Theme-Goal ditransitive verbs

The Agent θ-role is assigned to the DP daughter of vP; the Theme θ-role is assigned to the DP daughter of VP and the Goal θ-role is assigned

to the PP daughter of V'. In this way, the UTAH (Baker, 1988) is respected, i.e. every θ-role is always merged in the same position. For that reason, the structures of unergative, unaccusative and transitive verbs were also presented in VP-shells in sections 2.1.1. and 2.1.2.

Another verbal construction with three arguments is the double-object construction (with the direct and indirect object), presented in Figure 5. The DP 'a book' is merged as the daughter of V', which represents a problem for the UTAH, since the DP 'a book' cannot be assigned the Goal θ-role. Harley (2002) offers a solution by arguing that the double object verbs can be decomposed into two verbs: cause and have. Therefore, the interpretation of the sentence given in figure 5 would be 'He caused Mary to have a book'. In this way, the DP 'a book' gets the Possessee θ-role, which could be an adequate solution for the UTAH. The DP daughter of V' is assigned the Possessee θ-role, whereas the Goal θ-role is reserved for the PP daughter of V'. In this way, each theta-role has a consistent place in the structure.

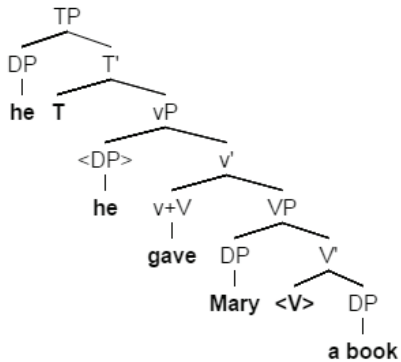

Figure 5 - Tree representation of Agent-Theme-Possessee ditransitive verbs

Regarding the acquisition of ditransitive verbs, the delay could be explained by Bever's Canonical Sentence Strategy (1970). As Bever (1970: 298) claims, "any Noun-Verb-Noun (NVN) sequence within a potential internal unit in the surface structure corresponds to 'actor-action-object'". This is the most usual correspondence between syntactic positions and thematic roles, which is why children at early stages of language acquisition may have problems with structures which do not follow this pattern. The

most frequent error that children commit with ditransitive verbs is interpreting the NP V NP NP sequence (agent goal theme), as the NP V NP PP sequence (agent theme goal) (Warayas & Stremel, 1974; Cook, 1976; Osgood & Zehler, 1981; Roeper et al., 1981). In this way, children prefer analyzing the distransitive construction as the construction containing a transitive verb and the preposition to (O'Grady, 1997). O'Grady (1997) formulates this interpretation as the Extended Canonical Sentence Strategy, in which the first NP after the verb is assigned the theme theta-role, as in simple transitive sentences, whereas the second NP is assigned the goal theta role.

2.1.4. Anti-causative verbs

Anti-causative verbs are a special type of unaccusative verbs, which have a transitive counter-part (unlike the rest of unaccusative verbs). Hence, these verbs have alternating transitivity and can be used both transitively (e.g. *John broke the window*) and intransitively (e.g. *The branch broke*). Although they do not have passive morphology, they are analyzed as being essentially like passives. The structure of anti-causative verbs is given in Figure 6. As it is shown, the structure apparently does not differ from the structure of other unaccusative verbs. However, the derivation of this type of verbs is discussed in greater detail in Reinhart's Theta System (2000, 2002).

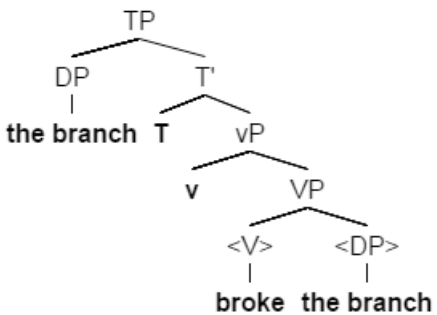

Figure 6 - Tree representation of anti-causative verbs

Reinhart's Theta system (2000, 2002) provides a possible description of mapping theta roles to syntactic structures. It makes the interface between conceptual and computational (syntactic) system. Since it is a der-

ivational approach, it is assumed that the mapping is not directly into the surface position, but that the movement operations can move arguments from their original VP-internal positions.

In Reinhart's system (2000, 2002) theta-roles are decomposed using formal primitives, i.e. two binary features: +/- c (cause change) and +/- m (mental state). All the theta-roles are defined as clusters of those features: Agent [+c, +m]; Instrument [+c, -m]; Experiencer [-c, +m]; Theme [-c, -m]; Cause [+c]; Recipient/Goal/Benefactor [-c]; Subject Matter/Source [-m]; Sentient[1] [+m]. Some theta-roles are specified only for one of the two features (e.g. Cause [+c]). This does not mean that the underspecified feature is necessarily absent. Actually, it can be assigned + or – value, or it can be completely absent. Only the verbs whose external argument bears [+c] feature can give anti-causative verbs.

Reinhart and Siloni (2005: 416) define decausativization (turning a transitive into an anti-causative verb) as the "reduction of an external [+c] role". The external argument is removed before the remaining argument is merged internally, which is why the position of the external argument is empty in Figure 6. At the final step of the derivation, after the internal argument is merged as the sister of V, it moves to a higher position of the specifier of TP, to become the subject, as shown in Figure 6.

2.2. Nativism

2.2.1. Fundamental ideas

One of the main approaches to the theory of language acquisition was outlined by Chomsky (1975, 1981, 1986) within the generative theory of Universal Grammar (UG). According to this theory, all human beings are endowed with the knowledge of UG. UG is the genetically transmitted language-faculty, which plays an essential role in children's acquisition of their native language, guiding them in the process of analyzing linguistic units. In the 60s, it was referred to as Language Acquisition Device (LAD). In the 80s, the UG theory became the theory of principles and parameters, in

[1] Reinhart (2002) introduces the sentient theta-role to refer to the subjects of verbs like *love* or *know*, which are always merged externally, as opposed to standard experiencers, which may have different realizations. They require animacy, but they do not require a causal element.

which principles stand for the similarities between languages (they are universal), whereas parameters account for the structural diversity of natural languages (Chomsky, 1981).

The UG theory explains how children acquire a language "without explicit teaching, on the basis of positive evidence (i.e. what they hear), under varying circumstances, and in a limited amount of time, in identical ways across languages" (Guasti, 2002: 3). In the process of LA, parents do not generally use any formal instruction. Hence, children acquire a language spontaneously, on the basis of the linguistic input they get in their environment. Corrections are rare, and even when they are present, children persist in making mistakes (Guasti, 2002). Moreover, research has shown that negative evidence is not always provided (Bowerman, 1988; Morgan & Travis, 1989; Marcus, 1993). Regardless of the varying amount of exposure, children acquire their native language in a limited amount of time. Furthermore, they do so in the same fashion despite the differences across languages (Guasti, 2002).

The fact that children acquire their native language within a limited period of time, with a relatively small amount of exposure, after which they are capable of creating sentences they have never heard before, led to the formulation of the Poverty of stimulus argument (Chomsky, 1980). This argument supports the existence of the mental linguistic capacity. Another term used for the same issue is Plato's problem (Chomsky, 1984), i.e. the question of how people know so much, when the information available to them is insufficient.

Another strong piece of evidence which speaks in favor of nativism is the critical period. Lenneberg (1967) suggests that a language can be acquired only if the acquisition takes place before the puberty. Different studies involving children deprived of linguistic interaction (Curtiss, 1977) and congenitally deaf people (Newport, 1984, 1988, 1990; Mayberry & Fischer, 1989; Mayberry & Eichen, 1991; Singleton & Newport, 2004) have shown that early exposure to language is crucial for gaining linguistic competence.

Two different approaches to the acquisition of the argument structure can be distinguished within the generative framework. Although the underlying principles are shared by both, different inducting mechanisms for the acquisition are defined. These will be described in sections 2.2.2 and 2.2.3. After that, research related to the acquisition of verbs will be briefly present-

ed. In sections 2.2.4 and 2.2.5, two directions can be noted as well – one which supports the Maturation Hypothesis (Borer & Wexler, 1987; Wexler, 1994) and the other, which supports Continuity (Costa & Friedmann, 2012; Lorusso, Caprin & Guasti, 2005; Snyder, Hyams & Crisma, 1995).

2.2.2. Semantic Bootstrapping Hypothesis

Although Pinker (1984, 1989) was the first one to discuss semantic bootstrapping, the term was actually coined by Gleitman (1990), who based her own theory of syntactic bootstrapping on the criticism of semantic bootstrapping. Let us first discuss the Semantic Bootstrapping Hypothesis.

The semantic Bootstrapping Hypothesis assumes that a child possesses not only abstract syntactic categories, but semantic notions as well (Pinker, 1984, 1989). As Pinker (1994: 385) states, "certain contingencies between perceptual categories and syntactic categories, mediated by semantic categories, could help the child get syntax acquisition started". The development of grammar involves finding out the right syntactic functions for the thematic roles of agent, theme, goal etc. (Pinker, 1984, 1989).

2.2.3. Syntactic Bootstrapping Hypothesis

As opposed to Pinker, Gleitman (Gleitman, 1990; Landau & Gleitman, 1985) believes that verb meanings cannot be learned by means of observation. She suggests that the direction of learning is not from semantics to syntax, but from syntax to semantics. A child makes inferences about the semantic roles of the participants and the relations between them on the basis of the syntactic frames in which a certain verb appears. Pinker (1994) suggests that this hypothesis should be termed prosodic rather than syntactic, since Gleitman claims that a child can parse a sentence into a syntactic tree, based on the prosody.

Gleitman (1990) uses three types of arguments to support the Syntactic Bootstrapping Hypothesis: negative evidence, positive hypothetical evidence and empirical evidence. Negative evidence is centered on the idea that children cannot learn the verb meaning from observation alone. Gleitman says that one situation can be described by using different verbs, which can be rather confusing for children acquiring a language. Pinker (1994) provides a counter-argument by claiming that verbs can be learned after they have been repeated in multiple contexts. Moreover, Gleitman says that

mental verbs present a serious problem, since their meaning cannot be inferred from the context. However, Pinker believes that children can infer the meaning of mental verbs in a manner similar to adults. They can rely on their own feelings and thoughts. Moreover, their mothers can sense their feelings and once they comment on it, this provides supplementary information about the verb meaning.

Regarding positive hypothetical evidence, Gleitman (1990) believes that verb meaning can be learned from verb syntax. For example, one of the things that can be learned is the number of arguments that a verb takes. Nonetheless, as Pinker (1994) claims, syntax cannot help much with root meanings. In other words, syntactic frames cannot tell the difference between various verb meanings.

Finally, empirical studies support the idea that children are able to infer verb meaning from syntax (Hirsh-Pasek et al., 1988; Naigles, 1990; Fisher et al., 1994). However, all of them exclude the possibility that children learned verbs relying solely on syntax (Pinker, 1994). All of these studies involved visual stimuli (videos and puppets); hence, observation cannot be excluded as part of the learning process in these experiments. Moreover, the study by Fisher et al. (1994) did not include any verb learning. On the contrary, it tested finding the right equivalents of verbs in English, which means that it tested the verbs the children had already acquired. As Pinker (1994) suggests, the only type of experiment which would prove that children can learn verb meaning from syntax would be the one in which children would only hear the verb used in different syntactic frames, without any visual stimuli or content words available.

At one point, Gleitman (1990) herself admits that some verbs are learned from the context: "the syntax is not going to give the learner information delicate and specific enough, for example, to distinguish between such semantically close items as *break, tear, shatter* and *crumble*. Luckily, these distinctions are almost surely of the kinds that can be culled from transactions with the world of objects and events" (1990: 35). Moreover, the Syntactic Bootstrapping Hypothesis implies a certain extent of circularity of the mechanism of acquisition, since a child needs to possess a certain level of linguistic knowledge (to make a difference between nouns and verbs, to recognize the semantic content of noun phrases etc.) in order to be able to analyze the items available from the syntactic frame (Anđelković, 2012). In response to such

criticism, some advocates of this approach (Fisher, Hall, Rakowitz & Gleitman, 1994) have claimed that it is enough to recognize the number of noun phrases in an utterance in order to put a verb into one of the syntactic categories. This implies that children are sensitive to the number of arguments, which is why they can be expected to acquire the verbs with the least number of arguments (intransitive verbs) first (Anđelković, 2012).

The syntactic and semantic bootstrapping hypotheses have spurred a wide range of research into the acquisition of verbs. However, researchers have not been unanimous in their conclusions. Whereas some of them have claimed that children's linguistic knowledge needs a certain amount of time to mature and to become native-like (which is contrast with Pinker's (1984, 1989) ideas), others have argued that children possess early knowledge of argument structure. Let us now look at these two directions into greater detail.

The Semantic Bootstrapping Hypothesis stands in opposition to the Syntactic Bootstrapping Hypothesis, but only to a certain extent. As Pinker claims (1994), one cannot eliminate the possibility that a child makes conclusions about the verb meaning based on the meaning of other words in its vicinity and not on the subcategorization frames, as claimed by Gleitman (1990). Moreover, he states that Gleitman misinterprets his theory. She defines it as a theory according to which children learn the meanings of verbs by observing the situations in which they appear. However, he says that his theory is "about how the child begins learning syntax" (1994: 385). He assumes the existence of universal linking rules, which are innate and help children draw conclusions. For instance, one linking rule is that agents are subjects of active sentences. Once a child recognizes a certain word as the agent in a given context, he/she can infer that that word is also in the position of the subject. Nevertheless, Pinker (1994) does not deny that at least a certain number of verbs is learned relying on the context. This is actually the greatest difference between the two theories.

2.2.4. Maturational delay – the Maturation Hypothesis

Borer and Wexler's (1987) influential study on the acquisition of movement speaks in favor of maturation of A-movement. A-movement (movement to an argument position) occurs with unaccusative, anti-causative, passive and raising constructions, when an argument moves from

a lower position inside the VP to the position of the specifier of the TP. Whereas A' movement (movement to a non-argument position) is available to children from the beginning of acquisition, A-movement is acquired later. Borer and Wexler (1987) termed this hypothesis the A-chain Deficit Hypothesis (the ACDH). The hypothesis was based on the observation that children have problems with passive constructions. After it was shown that children are capable of understanding passive constructions with actional verbs (Maratsos et al., 1985), Borer and Wexler (1987) claimed that children are successful with actional passives because they interpret them as adjectival. Namely, a sentence like *The box is opened* is ambiguous between a verbal and an adjectival reading, so children could employ the latter. Borer and Wexler (1987) also suggested that the problems with non-actional passives occur as a result of the children's inability to form A-chains. This hypothesis, in turn, has consequences for the children's use of unaccusative verbs. Since children are not capable of forming A-chains at an early age, Borer and Wexler's (1987) suggestion was that unaccusative verbs would either appear in VS order or they would be analyzed as unergative verbs. Miyamoto et al. (1999) tested the omission of topic, nominative and object markers by a Japanese-speaking child (2;3-3;0) and found that the omission of the nominative marker was most frequent with unaccusative verbs. Since the child did not omit the nominative marker with unergative and transitive verbs, their conclusion was that the A-chain was not performed with unaccusative verbs. Lee & Wexler (2001) obtained very similar results for the nominative marker drop in Korean, which is omitted more with unaccusative than with transitive and unergative verbs at the age of two. Ito & Wexler (2002) further examined nominative case omission and found that it was significantly higher for unaccusative verbs than for transitive and unergative verbs at the second stage of LA (2;2-3;0), but that this difference was virtually non-existent at the third stage of LA (3;1-3;7). The results at the third stage can be interpreted as evidence that children misanalyze unaccusative as unergative verbs.

Another piece of evidence for the maturation of A-chains comes from the study with Russian unaccusatives (Babyonyshev et al., 2001). In Russian, the genitive of negation construction, given in (1), is used with the nominal phrases that appear with unaccusative and passive verbs.

1) Olgi Borisovnoj net.
Olga Borisnovna.gen. isn't
'Olga Borisovna isn't here.' (Babyonyshev et al., 2001: 16)

The nominal phrases are generated as themes, but they can move to the position of the subject (the specifier of the TP), although they sometimes remain in situ. Babyonyshev et al. (2001) claimed that covert movement takes place when themes stay in the base-generated position. The children in the experiment (under the age of four) used nominal expressions in the genitive case with unaccusative verbs in less than 50% of cases. Otherwise, they used a nominative argument. The results therefore indicate that the children under the age of four use unaccusative verbs, but analyze them as unergative.

Sano (2000), Sano, Endo & Yamakoshi (2001) and Sano (2003) provided opposing evidence for the acquisition of unaccusative and passive verbs in Japanese. The children (from approximately 3 to 6 years old) in their studies had no difficulty understanding unaccusative verbs, which was not the case with passive constructions. Since both constructions involve A-chains, they claimed that this presents a problem for Borer and Wexler's (1987) ACDH. However, Machida et al. (2004) provided a counter-argument, by showing that the nominative case marker drop phenomenon and the syntactic analysis of full unaccusative verbs support the unergative misanalysis of unaccusative verbs. More evidence opposing the ACDH, which was obtained for the acquisition of verbs in different languages, will be discussed next.

2.2.5. Early knowledge of verbs – the Continuity Hypothesis

The second line of research on the acquisition of verbs carried out within the generative framework proposes that children are sensitive to syntactic differences from the earliest age. In contrast with Borer and Wexler's (1987) Maturation Hypothesis, Snyder, Hyams and Crisma (1995) found that children use different auxiliaries with reflexive and non-reflexive clitic pronouns successfully while acquiring French and Italian. In these languages, reflexive forms are used with the auxiliary BE, whereas non-reflexive forms are used with the auxiliary HAVE. Reflexive constructions are analyzed as unaccusative constructions, in which the direct object surfaces as the subject. Snyder, Hyams and Crisma's (1995) findings provide evidence against the idea that unergative and unaccusative verbs are analyzed in the

same way, since one French-speaking child (ranged over the ages 2;1;9 to 3;3;12) and three Italian-speaking children (all younger than three) selected the right auxiliary almost without any mistakes.

In their study on the acquisition of passives, Snyder and Hyams (2008) tried to attribute the difficulty that children have with passive constructions to the fact that the child needs to relate the surface subject with an underlying direct object. Moreover, there is another argument (demoted subject) which interferes. Snyder and Hyams (2008) did not approve of the idea that A-chains pose a problem, as Borer and Wexler (1987) aimed to prove. Rather, they suggested that the problem lies in structural and inherent case features, which are still not distinctive for young children. The demoted subject gets inherent features (the dative or prepositional case), whereas the promoted object gets structural features (the nominative case). This problem slowly decreases with age.

Lorusso, Caprin and Guasti (2005) conducted research based on a longitudinal and a cross-sectional corpus. Four children in the longitudinal corpus ranged in age from 18 to 36 months, whereas fifty-nine children in the cross-sectional corpus ranged in age from 22 to 35 months. The results indicate that children use overt subjects in Italian differently with different verb types. More specifically, they use overt subjects with unaccusatives more than with any other verb type. Interestingly, they use post-verbal subjects in greater proportion than pre-verbal subjects with unaccusative verbs, which is not the case with unergative and transitive verbs. This implies that children are able to make a distinction between different verb types. Furthermore, the fact that the children in the experiment treated the verbs with the same argument structure in the same way suggests that they had already made generalizations across different classes of verbs.

Costa and Friedmann (2012) showed that children can distinguish between unaccusative and unergative verbs very early. Their conclusion was made on the basis of the results obtained by the means of seven structured repetition and storytelling experiments and the analysis of spontaneous speech from seven large corpora of early child language in Hebrew and European Portuguese.[2] By consulting all these samples, Costa and Friedmann

[2] For European Portuguese, they analyzed spontaneous speech of a child between the ages of 2;7 and 3;7. Moreover, twenty-one European Portuguese-speaking children ranged in age from 2;1 to 3;0 were tested in the repetition experiment. For Hebrew, there was an

(2012) showed that children are not only sensitive to different word orders of the two types of verbs, but that they also perform A-movement when they utter SV unaccusative sentences. In order to discard the idea that children use unergative variants of unaccusative verbs when they produce SV order with unaccusative verbs, Costa and Friedmann (2012) used tasks in which children had to produce unaccusative verbs and possessive datives in SV and VS orders. An example of a possessive dative is given in (2):

2) Ha-ciyur nirtav le-miri.
the-drawing got-wet to-Miri
'Miri's drawing got wet.' (Costa & Friedmann, 2012: 21)

Given that possessive datives are allowed only with unaccusative verbs in Hebrew, the use of SV order with a possessive dative would imply that the children have performed A-movement. The results show that the children have no difficulty using SV order with possessive datives, which implies that children do not use unaccusative verbs while analyzing them as unergative.

2.3. Cognitive linguistics

2.3.1. A usage-based theory - fundamental ideas

A different account of first language acquisition, supporting the "nurture" side of the nature-nurture debate, has gained a lot of supporters recently. The supporters of this theory (Tomasello, 2003; Lieven, 2008) depart from the idea of the existence of the inborn mechanism for the acquisition of language and believe that language rules are learnt inductively. They reject the nativist Continuity hypothesis and argue in favor of the Discontinuity hypothesis. One of the main representatives of the usage-based theory,

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analysis of spontaneous speech of fifty-six children aged 1;6–6;1; one Hebrew-speaking girl between ages 1;7 and 2;11; and twenty-one children aged 1;6–2;11. Moreover, eighteen native speakers of Hebrew aged 2;3–3;10 were tested in the first repetition task; sixty children aged 2;2–3;10 were tested in the second repetition task; seventeen children aged 1;6–2;0 and seventeen children aged 1;9–2;0 were tested in the storytelling task; finally, seven children aged 2;0–3;0, and thirteen children aged 3;4–4;0 participated in the sentence repetition task with possessive datives and seventeen children aged 1;9–2;0 took part in the storytelling task with possessive datives.

within the cognitive linguistics framework, Tomasello (2003) argues that experience is crucial for acquisition. Moreover, he claims that acquisition happens through general cognitive processes of intention-reading and pattern-finding, which are characteristic of every human being. Intention-reading is related to the notion of cultural learning. It represents the process of acquiring conventional forms through the correspondence with the caregiver. It is through the social interaction that a child learns not only the lexical items, but grammatical rules as well.

Many studies have shown (Childers & Tomasello, 2001; Lieven, Pine & Baldwin, 1997; Lieven, 2008) that young children's language revolves around concrete exemplars, and not abstract grammatical categories. Two experiments which were carried out by Childers and Tomasello (2001) illustrate the children's inability to make generalizations. Fifty 2.5-year-old native speakers of English in the first experiment were asked to produce a new sentence, in which they would use the same pseudo-verb that had already been presented to them in a transitive sentence. However, one group of children heard a sentence with two nouns in the positions of the subject and object, whereas the other heard a sentence with a noun and a pronoun in the positions of the subject and object. Only the children who heard a pronoun and a noun were able to produce a new sentence. The second experiment, in which twenty-four 2.5-year-old English-speaking children were tested, gave the same results, but in comprehension. The results of the research were interpreted as evidence that early constructions are built around separate lexical units of high frequency (pronouns in this case). More abstract constructions are produced only later, on the basis of these individual schemes which children produce at the beginning of their grammatical development.

Lieven, Pine and Baldwin (1997) used a distributional analysis to analyze the speech of twelve children. The data were collected during the period of two years (approximately from the first till the third year of the participants). The results suggest that many of the utterances may be analyzed as "frozen", i.e. the children produce utterances that are centered around specific lexical items, which have been heard many times before. However, the authors argued that it is difficult to keep the same analysis when the child gets to 400 multiword utterances.

Finally, Lieven (2008) claims that distributional, item-based learning takes place in the process of language acquisition. Lieven also suggests that

frequency plays an essential role. Yet, at one point she adds that "it is clear that children are sensitive to the basic typological characteristics of their language from an early age" (2008: 454). That is why more research in the field is needed.

2.3.2. Early verbs in Serbian – a usage-based account

Recently, Anđelković (2012) looked into the production of verbs of Serbian-speaking children at the early stages of language acquisition (18-48 months). She analyzed early spontaneous production of eight children (four boys and four girls) given in Serbian Electronic Corpus of Children's Early Language (Anđelković, Ševa & Moskovljević, 2001), which is standardized according to the CHILDES system (MacWhinney, 1989). She provided an inventory of early verbs at the age of eighteen months and analyzed the development of the argument structure. Her analysis of the argument structure was done on the three verbs of high frequency: *dati* 'give', *imati* 'existential have' and *imati* 'transitive have' for the period between 18 and 28 months.

In her inventory of early verbs, Anđelković (2012) listed some non-transparent, relational, state and polysemous verbs, which she found at the earliest age (18 months). Taking these into account, she questioned the idea that polysemous verbs and verbs that are not perceptively available (e.g. state or psychological verbs such as 'wait' or 'love'*)* are acquired at later stages of language acquisition, as some other studies showed (Huttenlocher, Smiley, & Charney, 1983).

It is important to mention that Anđelković (2012) found verbs which are non-canonical (*imati* 'existential have') and verbs with three arguments (*dati* 'give') at the earliest age. Her analysis of the frequency of existential and transitive *imati* 'have' showed that these two verbs are quite equally balanced in early children's production. Thus, she brought into question Pinker's (1984, 1989) canonical linking hypothesis, as well as the nativist assumption that the verbs with the least number of arguments are acquired first (Fisher, Hall, Rakowitz, & Gleitman, 1994). However, I would not agree with Anđelković's (2012) claim that the existential *imati* 'have' is perceptively unavailable, since it is often used to refer to something that the child sees in the extra-linguistic reality, as was shown in this research.

Regarding Anđelković's (2012) analysis of the development of the argument structure of the verb *dati* 'give', she found that the use of the

'frozen' imperative *da(j)* 'give' dominated in the production at the earliest stage. It was only at the later stages that the children slowly began combining this verb with its arguments (first one and then more). However, Anđelković (2012) failed to mention that this form is rather problematic in Serbian, because it shows syncretism with the particle *daj*. Moreover, the children often used hyper-generalized meanings of the verb *dati* 'give' (in the situation of giving, taking or asking for something) in the corpus, which shows that they had still not acquired the structure and meaning of this verb completely at that point of acquisition.

Taking into consideration both the nativist and the usage-based account, as well as the studies done within these two frameworks, I expect that the present research into the production of verbs in a transversal study will tell us more about the argument structure that is available to children at different stages of acquisition. Since Anđelković (2012) found some unaccusative verbs produced at the earliest stage (18 months), I expect that the results of the present research could replicate this finding, especially because unergative and unaccusative verbs take only one argument and are therefore not syntactically very complex. Moreover, as it was mentioned, many nativist studies have provided evidence that children use unaccusative verbs from the earliest age (Snyder, Hyams & Crisma, 1995; Lorusso, Caprin & Guasti, 2005; Costa & Friedmann, 2012). I also expect that the youngest participants will be most successful with transitive verbs, which is in accordance with Canonical Linking Rules (Pinker, 1984, 1989). I do not expect, however, that children will produce ditransitive and anti-causative verbs correctly at the earliest stage of acquisition. Therefore, I am more prone to accept the nativist approach at this point. Yet, if these initial hypotheses prove to be false and if ditransitive and anti-causative verbs are produced at the earliest stages of language acquisition, this will provide evidence against nativism, i.e. in favor of the usage-based account.

3. Pilot research

3.1. Subjects

A total of twelve monolingual Serbian-speaking children were tested.[3] None of the children selected had any language impairment or learning disability. The task was aimed to test the participants belonging to six age groups: 1;6, 2;0, 2;6, 3;0, 3;6 and 4;0. Every age group was supposed to test three participants. However, only eight girls and four boys were tested. The age range was from 1;11 to 4;10. There were no younger children in the kindergarten, so they could not be tested. The children were divided into four age groups (three participants in each), roughly corresponding to the target age groups: 1;11-2;5, 2;6-3;2, 3;5-3;10 and 4;2-4;10 months. Mean ages per group were 2;3, 2;9, 3;8 and 4;5 months. Kindergarten teachers provided all the children's relevant information (the child's birth date). The children were tested in March 2015, in 'Tufnica' kindergarten, Novi Sad.

3.2. Stimuli

Once the stimuli for the verb elicitation task were prepared, a pilot test was conducted in order to make sure that the items were clear enough for the participants. The data collection technique was a structured interview. The participants performed a verb elicitation task. For this purpose, twenty-two verbs were chosen. Five verb types were tested in the experiment: unergative, simple transitive, unaccusative, ditransitive and anti-causative verbs.

The experiment consisted of two parts in which different stimuli were used. Two types of stimuli were chosen in order to check if one methodology was more sensitive to capturing the pattern of response. Puppets/toys were used to elicit verbs in the first part of the experiment, while colored drawings were used in the second part.

In the first part of the experiment, three unergative (*lajati* 'bark', *spavati* 'sleep', *skakati* 'jump'), three simple transitive (*jesti* 'eat', *piti* 'drink',

[3] I would like to express my gratitude to 'Tufnica' kindergarten, kindergarten principal Milka Radanović, all the employees and the children who participated in the pilot research, for their cooperation and significant contribution to the study.

pevati ‘sing’), two unaccusative (perfective *pasti* ‘fall’, *svetleti* ‘flash’), two ditransitive (*baciti* ‘throw’, *dati* ‘give’) and two anti-causative (*zatvoriti se* ‘close’, *ugasiti se* ‘turn off’) verbs were tested. Thus, there were a total of twelve verbs tested in this part. An example of a toy used as an item (‘bark’) is given in Figure 7.

Figure 7 - Toy stimulus

In the second part of the experiment, one unergative (*trčati* ‘run’), one simple transitive (*voziti* ‘drive’), four unaccusative (*nemati* existential ‘ not have’, *pući* ‘pop/burst’, imperfective *padati* ‘fall’, *sijati* ‘shine’), two ditransitive (*kupiti* ‘buy’, *staviti* ‘put’) and two anti-causative (*otvoriti se* ‘open’, *pokvariti se* ‘break’) verbs were tested i.e. ten verbs in total. An example of an item (‘run’) is given in Figure 8. The verbs were distributed in this way because it was easier to present some events with toys (e.g. ‘bark’), whereas others were depicted more easily with drawings (e.g. ‘run’). Moreover, the number of unaccusative verbs tested was bigger than the number of any other verb type tested, because it was difficult to find suitable stimuli for this group of verbs and predict which of them would be clear enough.

Figure 8 - Drawing stimulus

3.3. Procedure

Parental consent forms were obtained prior to the testing for every child. Parents also gave their permission for the sessions to be audio-taped using a Dictaphone/voice recorder. Twelve participants were tested in single sessions that lasted up to 10 minutes.

Each child was tested individually, in one of the rooms provided by the staff. The only people present were the interviewer and the interviewee. Occasional interruptions were unavoidable, because some of the children in the kindergarten wanted to assist the interviewer and it was challenging to prevent them from entering the testing room a few times. External noise was also present in some cases. However, the children were very interested in the task, which is why these occasional interruptions did not distract them.

First, the interviewer was introduced to the children who would be tested. They spent some time together before the testing began. The children were introduced to the puppets and told that they would see and say what the puppets were doing. The procedure consisted of the experimenter describing situations, one by one. After the situation was described, the experimenter would ask the participant what the puppet was doing. An example of a situation that was presented to the children is given below, followed by the expected answer:

"Interviewer: There is a dog here. Hello, dog. He is very tired, so we now need to put a blanket over him. And now the dog… (Imitation of snoring) What is he doing now?

Interviewee: He is sleeping.

Interviewer: Yes, very good."

The second part of the interview consisted of questions related to drawings. Each visual stimulus included two related pictures presenting a single situation. The child was expected to look at the picture and the interviewer would ask him/her what the person in the picture was doing in the case of animate arguments of the verb or what happened in the case of inanimate ones. An example of one situation is the following:

"Interviewer: Oh, look at this box. What happened to it in the second picture?

Interviewee: It opened.

Interviewer: Good."

The interviewer would give some positively neutral feedback and make a short break between two situations. If the child did not respond, the interviewer would repeat the question. If the child remained silent, the interviewer would go on to the next question.

4. Results

4.1.1. Group 1 – overall production

Two girls (LEN 2;4 and ILI 2;5) and one boy (NIK 1;11) were tested in this group. NIK did not respond to any of the given questions. As it can be seen in table 1, LEN and ILI were most successful in the production of unergative and transitive verbs (both show a subject-agent correspondence). The production of unaccusative verbs was a bit lower. The production of ditransitive verbs was even less successful and only LEN produced them. There were no anti-causative verbs produced in this group.

Participant	LEN 2;4		ILI 2;5	
	Target answers	Alternative answers	Target answers	Alternative answers
Unergative verbs	2/4 (50%)	2	4/4 (100%)	0
Transitive verbs	3/4 (75%)	1	4/4 (100%)	0
Unaccusative verbs	3/6 (50%)	3	3/6 (50%)	1
Ditransitive verbs	2/4 (50%)	2	0/4 (0%)	3
Anti-causative verbs	0/4 (0%)	4	0/4 (0%)	3

Table 1 - Pilot test results group 1

As far as alternative answers are concerned, LEN gave onomatopoeic answers instead of unergative verbs (*kaže av av* 'say.3sg.pres. woof woof'; *hop* 'hop'). LEN used the verb *kazati* 'say' and repeated the sounds she heard from the interviewer instead of producing the transitive verb *pevati* 'sing' (*kažeš la la la* 'say.2sg.pres. la la la').

When it comes to the unexpected production of unaccusative verbs, LEN again used the verb *kazati* 'say' and repeated the sounds she heard from the interviewer (*kaže bum bum* 'say.3sg. boom boom' instead of the target verb *pući* 'pop/burst'); instead of the target verb *sijati* 'shine', she used the synonymous verb *svetleti* 'flash'. ILI did not give any answers for the target verbs *pasti* 'fall' and *svetleti* 'flash'. Both LEN and ILI produced the existential *imati* 'have' instead of the target existential *nemati* 'not have', because they interpreted the crumbs that were presented on the drawing as the remainings of the food. Thus, they said: *ima malo* 'have.3sg.pres. little'.

Alternative answers for ditransitive verbs were diverse as well. LEN used the verb *bacila* 'throw.3sg.fem' instead of the verb *dati* 'give'. It is interesting to note that the verb *baciti* 'give' was the target verb in the situation that immediately preceded the situation of giving, which may be the reason why LEN chose this verb. Instead of producing the target verb *kupiti* 'buy', LEN produced the following utterance:

3) Uzela je ove pare.
take.sg.past this money.ACC
'She took this money.'

ILI's alternative answers for ditransitive verbs were interesting as well. She used the same word the interviewer used to describe the situation of throwing (*(h)vata* 'catch.2sg.pres'). Then, she produced the following utterance for the situation of buying a car:

4) Pravila auto.
made.sg.fem car.ACC
'She made a car.'

ILI also used the ditransitive verb *skloniti* 'put away' instead of the verb *staviti* 'put', which implies that she has acquired the structure of ditransitive verbs, at least to a certain extent. She did not give any answer for the target verb *dati* 'give'.

Finally, alternative answers for anti-causative verbs included transitive variants of anti-causative verbs, as exemplified in (5).

5) Bilo je da upalimo svetlo a sad je lepo.
was to turn on.1.pl.pres light.NOM and now is nice
'It happened that we turned on the light, and now it is nice.'

Otherwise, participants would choose an unaccusative verb, as in the following case, in which an opened box was presented:

6) Nema ništa.
'has nothing'
There is nothing. (Her interpretation was that there was nothing in the box that opened)

4.1.2. Unergative verbs

The production of unergative verbs was more successful than the production of any other verb type, apart from transitive verbs. The comparison of the production of unergative verbs presented by toys and the ones presented by drawings is given in Table 2. The results represent the number of participants who produced the verb correctly given in percentages (i.e. 100% is given in case all the participants responded correctly). Only LEN and ILI gave answers, whereas NIK did not give any response. As far as

the verbs tested with toys are concerned, both LEN and ILI produced the verb *spavati* 'sleep', but the verbs *lajati* 'bark' and *skakati* 'jump' were not produced by LEN. We can see that the production was better for the verb *trčati* 'run', which was tested using a drawing, and which resulted in two correct answers.

Unergative verbs - toys	Production
lajati 'bark'	33.3% (1)
spavati 'sleep'	66.7% (2)
skakati 'jump'	33.3% (1)
Unergative verbs - drawings	Production
trčati 'run'	66.7% (2)

Table 2 – Unergative verbs group 1

4.1.3. Transitive verbs

The production of transitive verbs was the most successful. As shown in Table 3, the verbs *jesti* 'eat' and *piti* 'drink', which were tested with toys, and the verb *voziti* 'drive', which was tested with a drawing, were all produced by LEN and ILI. The verb *pevati* 'sing', which was tested with a toy, was produced only by ILI.

Transitive verbs - toys	Production
jesti 'eat'	66.7% (2)
piti 'drink'	66.7% (2)
pevati 'sing'	33.3% (1)
Transitive verbs - drawings	Production
voziti 'drive'	66.7% (2)

Table 3 – Transitive verbs group 1

4.1.4. Unaccusative verbs

The production of unaccusative verbs was lower than the production of unergative and transitive verbs. As shown in table 4, the verbs for which the production was the highest were the verbs *padati* 'fall' and *sijati* 'shine', which were tested with drawings. The verbs *pasti* 'fall' and *svetleti* 'flash' were produced only by LEN. The verb *pući* 'pop/burst' was produced only by ILI. There were no responses for the existential verb *nemati* 'not have',

even though this was a result of the participants' misinterpretation of the drawing, which has already been mentioned in section 4.1.1.

Unaccusative verbs - toys	Production
pasti 'fall'	50% (1)
svetleti 'flash'	50% (1)
Unaccusative verbs - drawings	Production
nemati 'have'	0% (0)
pući 'pop/burst'	50% (1)
padati 'fall'	100% (2)
sijati 'shine'	100% (2)

Table 4 – Unaccusative verbs group 1

4.1.5. Ditransitive verbs

Ditransitive verbs were produced, but their production was quite low, which is presented in table 5. LEN produced the verb *baciti* 'throw', which was presented with toys, and the verb *staviti* 'put', which was presented with a drawing. The verbs *dati* 'give' and *kupiti* 'buy' were not produced. Therefore, there was no difference in the production of verbs tested with toys and those tested with drawings.

Ditransitive verbs - toys	Production
baciti 'throw'	33.3% (1)
dati 'give'	0% (0)
Ditransitive verbs - drawings	Production
kupiti 'buy'	0% (0)
staviti 'put'	33.3% (1)

Table 5 – Ditransitive verbs group 1

4.2.1. Group 2

Three girls were tested in this group (MIL 2;6, MIA 2;7 and ANJI 3;2). As shown in Table 6, the production of transitive verbs was the most successful. The production of unergative verbs immediately followed, whereas the production of unaccusative and ditransitive verbs was lower. Anti-causative verbs were produced in this group, but their production was still quite low.

Participant	MIL 2; 6		MIA 2; 7		ANJI 3; 2	
	Target answers	Alternative answers	Target answers	Alternative answers	Target answers	Alternative answers
Unergative verbs	3/4 (75%)	0	2/4 (50%)	1	3/4 (75%)	1
Transitive verbs	3/4 (75%)	0	3/4 (75%)	0	4/4 (100%)	0
Unaccusative verbs	3/6 (50%)	0	2/6(33.3%)	2	2/6(33.3%)	2
Ditransitive verbs	1/4 (25%)	2	2/4 (50%)	2	2/4 (50%)	2
Anti-causative verbs	0/4 (0%)	0	2/4 (50%)	1	1/4 (25%)	3

Table 6 - Pilot test results group 2

Alternative answers in Group 2 were as diverse as alternative answers in Group 1. There was one onomatopoeic answer *hop* 'hop' instead of the target verb *skakati* 'jump' given by MIA. MIL and MIA did not give any answer for the target verb *lajati* 'bark'. However, ANJI responded with the verb *pričati* 'talk' instead, as shown in (7):

7) Glasno priča.
loudly speak.3sg.pres
'He speaks loudly.'

There were no alternative responses for transitive verbs. MIL and MIA remained silent when they were supposed to produce the verb *pevati* 'sing'. On the other hand, the participants produced many alternative answers for unaccusative verbs. The stimulus which elicited the greatest number of different interpretations was the stimulus for the verb *sijati* 'shine'. From the participants' responses, it is clear that they treated the sun as an agent, not as a patient. MIA produced the utterance given in (8) and ANJI the one given in (9):

8) Kada padne mrak onda dolaci [dolazi] cunce [sunce].
when fall.3.sg.pres dark.NOM then come.3.sg.pres sun.NOM
'When the dark comes then comes the sun.'

Sunce je palo tu dole da se igra.
sun.NOM fall.sg.past.neut here down to se play
'The sun fell down here to play.'

It is important to comment on the alternative responses for the verb pući 'pop/burst'. MIA and ANJI actually produced syntactically more complex verbs instead of the target verb. Both of them produced anti-causative verbs. MIA produced the verb *pokvajio se* 'broke.3sg.past' and ANJI produced the verb *polomilo se* 'break.3sg.neut.past', in which gender mismatch is present. Finally, the participants remained silent for the verbs *pasti* 'fall' and *flash* 'svetleti'.

As in the previous group, the participants would use the same word the interviewer used to describe the situation of throwing (*hvata* 'catch.2sg.pres'). Otherwise, they would use another ditransitive verb instead of the target one. For example, MIL produced the verb *baciti* 'throw' instead of the verb *staviti* 'put'. ANJI produced the utterance given in (10), with the ditransitive verb *dati* 'give' instead of the target verb *kupiti* 'buy':

9) Mama je dala dečaku ovo.
mother.NOM give.3sg.past boy.DAT this.ACC
'The mother gave the boy this.'

MIA produced the utterance in (11) instead of the target verb 'buy':

10) E(v)o ti poklon.
evo.part you present.NOM
'Here is your present.'

Finally, anti-causative verbs were again the most problematic group. There were only three correct answers. MIL did not give any answers for the target anti-causative verbs. MIA and ANJI produced transitive variants of anti-causative verbs, as shown in (12):

11) Svetlo je izgasio.
light turn off.3sg.past
'He turned off the light.'

4.2.2. Unergative verbs

The production of unergative verbs was not as successful as the production of transitive verbs, but it was more successful than the production of other verb types. The comparison of the production of unergative verbs presented by toys and the ones presented by drawings is given in Table 7. As far as the verbs tested with toys are concerned, all participants produced the verb *spavati* 'sleep'. The verb *lajati* 'bark' was not produced at all and the verb *skakati* 'jump' was not produced only by MIA. We can see that the production was better for the verb *trčati* 'run', which was tested using a drawing, and which was produced by all the participants.

Unergative verbs - toys	Production
lajati 'bark'	0% (0)
spavati 'sleep'	100% (3)
skakati 'jump'	66.7% (2)
Unergative verbs - drawings	Production
trčati 'run'	100% (3)

Table 7 – Unergative verbs group 2

4.2.3. Transitive verbs

The trend of a better production of transitive than any other type of verbs continued in this group as well. The results are presented in Table 8. The verbs *jesti* 'eat' and *piti* 'drink', which were tested by means of toys, were produced by all the participants, as well as the verb *voziti* 'drive', which was tested using a drawing. There was one correct answer for the verb *pevati* 'sing' in this group, given by ANJI.

Transitive verbs - toys	Production
jesti 'eat'	100% (3)
piti 'drink'	100% (3)
pevati 'sing'	33.3% (1)
Transitive verbs - drawings	Production
voziti 'drive'	100% (3)

Table 8 – Transitive verbs group 2

4.2.4. Unaccusative verbs

The production of unaccusative verbs was again considerably lower than the production of unergative and transitive verbs. The only verb for which the production was higher than in the previous group was the existential verb *nemati* 'not have', which was produced by all the participants. The verb *padati* 'fall' also reached maximum production. There were no correct responses for the verbs *pasti* 'fall', *svetleti* 'flash' and *sijati* 'shine'. The verb *pući* 'pop/burst' was produced by MIL only. As it can be seen in Table 9, the production was more successful for the verbs tested using drawings. However, as it has already been mentioned before, the children used some syntactically more complex verbs instead of the target unaccusative verbs.

Unaccusative verbs - toys	Production
pasti 'fall'	0% (0)
svetleti 'flash'	0% (0)
Unaccusative verbs - drawings	Production
nemati 'have'	100% (3)
pući 'pop/burst'	33.3% (1)
padati 'fall'	100% (3)
sijati 'shine'	0% (0)

Table 9 – Unaccusative verbs group 2

4.2.5. Ditransitive verbs

Ditransitive verbs were produced, but their production was still quite low, which is presented in table 10. The verb *dati* 'give' was produced by MIA and ANJI and the verb *baciti* 'throw' was produced by MIL. The verb *kupiti* 'buy' was not produced at all, whereas the verb *staviti* 'put' was produced by MIA and ANJI. The production of verbs tested with toys was a somewhat better.

Ditransitive verbs - toys	Production
baciti 'throw'	33.3% (1)
dati 'give'	66.7% (2)
Ditransitive verbs - drawings	Production
kupiti 'buy'	0% (0)
staviti 'put'	66.7% (2)

Table 10 – Ditransitive verbs group 2

4.2.6. Anti-causative verbs

This group was the first one to produce anti-causative verbs. The production was very low. As presented in Table 11, the verbs *zatvoriti se* 'close' and *ugasiti se* 'turn off', which were tested with toys, were not produced. As far as the verbs tested using drawings are concerned, their production was somewhat better. The verb *otvoriti se* 'open' was produced by MIA and ANJI, while the verb *pokvariti se* 'break' was produced only by MIA.

Anti-causative verbs - toys	Production
zatvoriti se 'close'	0% (0)
ugasiti se 'turn off'	0% (0)
Anti-causative verbs - drawings	Production
otvoriti se 'open'	66.7% (2)
pokvariti se 'break'	33.3% (1)

Table 11 – Anti-causative verbs group 2

4.3.1. Group 3

Two boys (DAN 3;5 and FIL 3;10) and one girl (NIK 3;9) were tested in this group. As presented in Table 12, all the participants produced all the target unergative and transitive verbs. The production of unaccusative verbs was better than in the previous two groups. The production of ditransitive and anti-causative verbs was also better, but it was still around 50%.

Participant	DAN 3; 5		NIK 3; 9		FIL 3; 10	
	Target answers	Alternative answers	Target answers	Alternative answers	Target answers	Alternative answers
Unergative verbs	4/4 (100%)	0	4/4 (100%)	0	4/4(100%)	0
Transitive verbs	4/4 (100%)	0	4/4 (100%)	0	4/4 (100%)	0
Unaccusative verbs	4/6 (66.7%)	2	3/6 (50%)	3	4/6(66.7%)	2
Ditransitive verbs	2/4 (50%)	2	2/4 (50%)	2	3/4 (75%)	1
Anti-causative verbs	2/4 (50%)	2	2/4 (50%)	2	2/4 (50%)	2

Table 12 - Pilot test result group 3

The number of alternative answers in this group decreased. The stimulus which elicited the biggest number of diverse interpretations was again the stimulus for the unaccusative verb *sijati* 'shine'. Some responses are given in (13) and (14).

12) Sunce bode.
sun.NOM pierces.3sg.pres
'The sun pierces.'

13) Sunce visi gore.
sun.NOM hang.3sg.pres up
'The sun is hanging up.'

As opposed to the previous two groups, the production of the verb *padati* 'fall' was not 100%. There was one alternative answer, produced by FIL:

14) Kiša poliva njega.
rain.NOM pour.3sg.pres him
'The rain is pouring on him.'

Another interesting alternative answer for the verb *pasti* 'fall' is given in (16). It is clear that NIK interpreted the ball as an agent, and not as a patient.

15) Pobeglo na pod.
run away.sg.past.neut on floor.ACC
'It ran away to the floor.'

NIK also used the particle *ne* 'no', instead of producing the existential verb *nemati* 'not have'.

As far as alternative answers for ditransitive verbs are concerned, NIK often used the ditransitive verb *dati* 'give' instead of other target ditransitive verbs, such as in (17), when she used it instead of the target verb *staviti* 'put'. This shows that although she has acquired the structure of ditransitive

verbs, hyper-generalization of meaning is still present in her speech, since the verb *dati* 'give' cannot be used in this context.

16) Dala na pod.
give.sg.past.fem on floor.ACC
'You gave on the floor.'

DAN also used the ditransitive verb *dati* 'give' instead of the target verb *kupiti* 'buy'. Moreover, he used a rather unusual construction instead of the verb *staviti* 'put', given in (18). This verb was also problematic for FIL, who used the transitive verb *imati* 'have' instead (19).

17) Sad nema ruke.
now not have.3.sg.pres hand.GEN
'Now there is no hand.'
18) Ima paket.
have.3sg.pres parcel.ACC
'He has a parcel.'

Alternative answers for anti-causative verbs included transitive variants of the target verbs. Sometimes, the participants would use the anti-causative verb *nemati* 'not have', as in the following utterance produced by FIL:
19) Nema igračaka.
not have.3sg.pres toys.GEN
'Now there is no hand.' (In the open box)

It should be said that the results for DAN and NIK for the anti-causative verbs *zatvoriti se* 'close' and *ugasiti se* 'turn off' are discarded, because the interviewer used a question which urged the children to answer with transitive verbs (What did I do with the door/lights?). The other two verbs tested can be taken into account, because different stimuli and questions were used.

4.3.2. Unergative verbs

The production of unergative verbs was successful and it was equal to the production of transitive verbs. It was higher than the production of unac-

cusative, ditransitive and anti-causative verbs. As presented in Table 13, all the verbs, the ones tested with toys and the ones tested with drawings, were produced by all the participants.

Unergative verbs - toys	Production
lajati 'bark'	100% (3)
spavati 'sleep'	100% (3)
skakati 'jump'	100% (3)
Unergative verbs - drawings	Production
trčati 'run'	100% (3)

Table 13 – Unergative verbs group 3

4.3.3. Transitive verbs

The production of transitive verbs equaled the production of unergative verbs. As it can be seen in Table 14, all the transitive verbs were produced by all the participants, regardless of the type of stimulus that was used.

Transitive verbs - toys	Production
jesti 'eat'	100% (3)
piti 'drink'	100% (3)
pevati 'sing'	100% (3)
Transitive verbs - drawings	Production
voziti 'drive'	100% (3)

Table 14 – Transitive verbs group 3

4.3.4. Unaccusative verbs

As opposed to the results in the previous groups, this group produced unaccusative verbs quite successfully. The verb *pući* 'pop/burst', which was tested with a toy, was produced by all the participants. The imperfective verb *padati* 'fall' was produced by DAN and NIK. The verb *svetleti* 'flash' was produced by FIL and NIK. The verbs *pasti* 'fall' and *nemati* 'not have' were produced by DAN and FIL. The only stimulus which did not elicit any target responses was the stimulus for the verb *sijati* 'shine'. The results are given in Table 15.

Unaccusative verbs - toys	Production
pasti ‘fall’	66.7% (2)
svetleti ‘flash’	66.7% (2)
Unaccusative verbs - drawings	Production
nemati ‘have’	66.7% (2)
pući ‘pop/burst’	100% (3)
padati ‘fall’	66.7% (2)
sijati ‘shine’	0% (0)

Table 15 – Unaccusative verbs group 3

4.3.5. Ditransitive verbs

The production of ditransitive verbs was more successful than the production of ditranstive verbs in any of the previous groups, which is presented in Table 16. The verb *dati* ‘give’, which was tested with toys, was produced by all the participants. The verb *baciti* ‘throw’, which was also presented with toys, was produced by DAN and FIL. On the other hand, the verbs presented with drawings had a lower production. The verb *kupiti* ‘buy’ was produced only by NIK, whereas the verb *staviti* ‘put’ was produced only by FIL. Therefore, the verbs tested with toys had a better production than those tested with drawings in this group.

Ditransitive verbs - toys	Production
baciti ‘throw’	66.7% (2)
dati ‘give’	100% (3)
Ditransitive verbs - drawings	Production
kupiti ‘buy’	33.3% (1)
staviti ‘put’	33.3% (1)

Table 16 – Ditransitive verbs group 3

4.3.6. Anti-causative verbs

As presented in Table 17, the production of anti-causative verbs tested with drawings was quite successful. The verb *pokvariti se* ‘break’ was produced by all the participants, whereas the verb *otvoriti se* ‘open’ was produced by DAN and NIK. The verb *zatvoriti se* ‘close’, which was tested with toys, was not produced. The verb *otvoriti se* ‘open’ was produced only by FIL. However, as it was explained in section 4.3.1. this happened as a result of the faulty formulation of the question used to elicit these verbs.

Anti-causative verbs - toys	Production
zatvoriti se 'close'	0% (0)
ugasiti se 'turn off'	33.3% (1)
Anti-causative verbs - drawings	Production
otvoriti se 'open'	66.7% (2)
pokvariti se 'break'	100% (3)

Table 17 – Anti-causative verbs group 3

4.4.1. Group 4

Two girls (ANA 4;2 and MIA 4;10) and one boy (KON 4;3) were tested in this group. As shown in Table 18, the production of different verb types was quite similar. Transitive verbs were produced by all the participants and the production of unergative, unaccusative and ditransitive verbs was only slightly lower. The production of anti-causative verbs was also quite successful for all the participants, except for ANA.

Participant	ANA 4; 2		KON 4; 3		MIA 4; 10	
Unergative verbs	3/4 (75%)	1	4/4 (100%)	0	4/4(100%)	0
Transitive verbs	4/4 (100%)	0	4/4 (100%)	0	4/4 (100%)	0
Unaccusative verbs	4/6 (66.7%)	2	6/6 (100%)	0	6/6(100%)	0
Ditransitive verbs	4/4 (100%)	0	3/4 (66.7%)	1	4/4 (100%)	0
Anti-causative verbs	1/4 (33.3%)	3	4/4 (100%)	0	4/4 (100%)	0

Table 18 - Pilot test result group 4

There were not a lot of alternative answers given in this group. Surprisingly, ANA responded with an onomatopoeic answer for the target verb *lajati* 'bark' (*av, av* 'woof woof'). She also gave two alternative answers for unaccusative verbs. Instead of producing the target existential verb *nemati* 'not have', she used a pronoun *ništa* 'nothing'. She produced the verb *bosti*

'spike', which was also used by some of the participants from the previous groups, instead of the target verb *sijati* 'shine'.

There was only one alternative answer in the group of ditransitive verbs. KON used the verb *dati* 'give' instead of the verb *kupiti* 'buy'.

Finally, ANA used transitive variants of the anti-causative verbs *zatvoriti se* 'close' and *ugasiti se* 'turn off'. However, these are discarded, because the interviewer used a question which urged the children to answer with transitive verbs, as in the case of DAN and NIK from the previous group.

4.4.2. Unergative verbs

The production of unergative verbs was successful and it was similar to the production of other verb types. As presented in Table 19, all the verbs were produced by all the participants, with the exception of the verb *lajati* 'bark', which was not produced by ANA.

Unergative verbs - toys	Production
lajati 'bark'	66.7% (2)
spavati 'sleep'	100% (3)
skakati 'jump'	100% (3)
Unergative verbs - drawings	Production
trčati 'run'	100% (3)

Table 19 – Unergative verbs group 4

4.4.3. Transitive verbs

As it can be seen in Table 20, all the transitive verbs were again produced by all the participants, regardless of the type of stimulus that was used. Transitive verbs were the only group of verbs that reached the maximum production in two of the four groups tested.

Transitive verbs - toys	Production
jesti 'eat'	100% (3)
piti 'drink'	100% (3)
pevati 'sing'	100% (3)
Transitive verbs - drawings	Production
voziti 'drive'	100% (3)

Table 20 – Transitive verbs group 4

4.4.4. Unaccusative verbs

This group produced unaccusative verbs successfully. Four out of six verbs tested reached the maximum production. The verbs *pasti* 'fall', *svetleti* 'flash', *pući* 'pop/burst' and *padati* 'fall' were produced by all the participants. The verbs *nemati* 'have' and *sijati* 'shine', which were tested with drawings, were not produced by ANA only. The results are given in Table 21.

Unaccusative verbs - toys	Production
pasti 'fall'	100% (3)
svetleti 'flash'	100% (3)
Unaccusative verbs - drawings	Production
nemati 'have'	66.7% (2)
pući 'pop/burst'	100% (3)
padati 'fall'	100% (3)
sijati 'shine'	66.7% (2)

Table 21 – Unaccusative verbs group 4

4.4.5. Ditransitive verbs

The production of ditransitive verbs was as successful as the production of unergative verbs, and only to some extent lower than the production of transitive verbs. The verbs *dati* 'give' and *baciti* 'throw', which were tested with toys, and the verb *staviti* 'put', which was presented with a drawing, were produced by all the participants, which is presented in Table 22. The verb *kupiti* 'buy' was not produced only by KON, who replaced it with the verb *dati* 'give'.

Ditransitive verbs - toys	Production
baciti 'throw'	100% (3)
dati 'give'	100% (3)
Ditransitive verbs - drawings	Production
kupiti 'buy'	66.7% (2)
staviti 'put'	100% (3)

Table 22 – Ditransitive verbs group 4

4.4.6. Anti-causative verbs

As presented in Table 23, the production of anti-causative verbs was much higher than the production of anti-causative verbs in the previous

groups. The verb *pokvariti se* 'break' was produced by all the participants, whereas the verbs *otvoriti se* 'open', *zatvoriti se* 'close' and *ugasiti se* 'turn off' were not produced only by ANA. However, as it was explained in section 4.4.1. the faulty formulation of the question used to elicit the verbs *zatvoriti se* 'close' and *ugasiti se* 'turn off' urged ANA to answer with the transitive variants of these verbs.

Anti-causative verbs - toys	Production
zatvoriti se 'close'	66.7% (2)
ugasiti se 'turn off'	66.7% (2)
Anti-causative verbs - drawings	Production
otvoriti se 'open'	66.7% (2)
pokvariti se 'break'	100% (3)

Table 23 – Anti-causative verbs group 4

4.5. Production of different verb types across groups

Separate analyses of verb production in different groups have already shown that transitive verbs proved to be the least problematic verb type tested. In Table 24, we can see that the verb type with the greatest number of correct verbs produced (7) in group 1 were transitive verbs. In group 2, that number increased to 10, and in groups 3 and 4, it reached the maximum. As far as unergative verbs are concerned, the number of verbs produced in the first two groups was only a bit lower than the number of transitive verbs produced, and was very high for the remaining two groups as well. As far as unaccusative verbs are concerned, Table 24 shows that their production was quite similar to the production of unergative verbs. However, what needs to be said is that the number of stimuli used to test unaccusative verbs was higher than any other, which influenced the results obtained. Finally, the production of ditransitive and anti-causative verbs was delayed. Group 1 produced only two ditransitive verbs, after which the number of ditransitive verbs steadily increased across groups. Anti-causative verbs were first produced in the second group. Their production slowly increased, although this slow increase may be the result of the formulation of some questions, which has already been mentioned in sections 4.3.1 and 4.4.1.

Verb type	1;11-2;5	2;6-3;2	3;5-3;10	4;2-4;10
Unergative verbs	6/12	8/12	12/12	11/12
Transitive verbs	7/12	10/12	12/12	12/12
Unaccusative verbs	6/18	7/18	11/18	16/18
Ditransitive verbs	2/12	5/12	7/12	11/12
Anti-causative verbs	0/12	3/12	6/12	9/12

Table 24 – Production of different verb types across groups

Figure 9 graphically shows how the production of ditransitive and anti-causative verbs was delayed in relation to other verb types. It has to be stressed that the results for unaccusative verbs are not as realistic as the results for other verb types, since this was the only verb type tested with six stimuli. That is the reason why the line for unaccusative verbs seems to reach better production in comparison with others. This does not imply that unaccusative verbs are more problematic in comparison to other verb types, but that other types should be tested with more stimuli in future research.

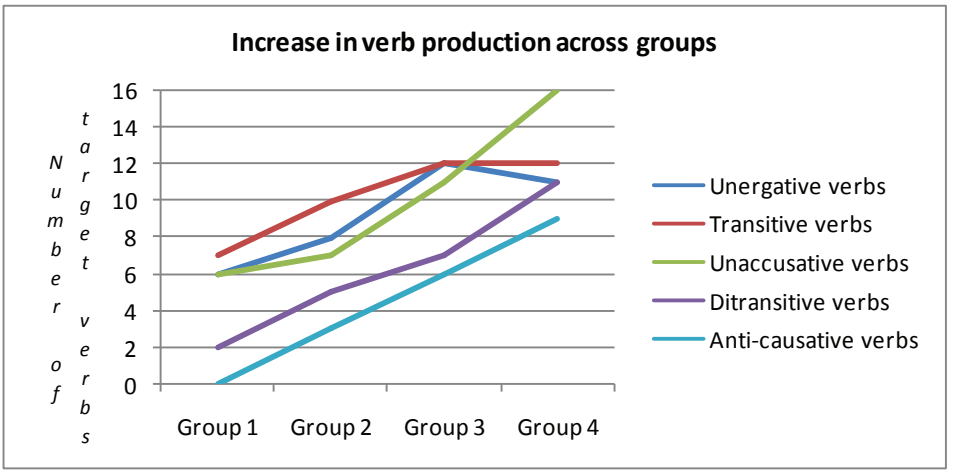

Figure 9 – Increase in verb production across groups

5. Discussion

5.1. Implications for the nature-nurture debate

The major finding of this study is that syntactically more complex verbs seem to be acquired after less complex ones, which is in line with Pinker's Canonical Linking Hypothesis (1984, 1989). This especially refers to ditransitive and anti-causative verbs. Reflecting on the debate whether unaccusative verbs are learnt early (Snyder, Hyams & Crisma, 1995; Lorusso, Caprin & Guasti, 2005; Snyder & Hyams, 2008; Costa & Friedmann, 2012) or there is a maturational delay with A-chains (Borer & Wexler, 1987; Miyamoto et al., 1999; Lee & Wexler, 2001, Ito & Wexler, 2002; Babyonyshev et al., 2001; Machida et al., 2004), it is important to stress that the present results do not support maturational delay, since unaccusative verbs were produced even by the youngest participants. Therefore, they speak in favor of the Continuity Hypothesis.

The difficulty with anti-causative verbs cannot be attributed to the children's problem with the formation of A-chains, since even the youngest participants produced unaccusative verbs. It may lie in linking the surface subject with an underlying object position, as Snyder and Hyams (2008) suggested for passive constructions.

Hypothesizing possible reasons why the acquisition of ditransitive verbs is delayed, it is interesting to discuss some of the conclusions reached in relation to intentional verbs. In their study, Huttenlocher et al. (1983) found that children (22-30 month old) could produce and comprehend both verbs of motion and intentional verbs. Yet, they produced and understood both type of verbs only when they were the agents of the target actions. When they were supposed to identify actions of other people, they could only identify movement. Huttenlocher et al. (1983) suggested that that is because children are unable to identify intentions of other people. As it was pointed out in the analyses of the children's utterances in the youngest two groups tested, most of these were produced while the children were involved in the action in some way. This may also be one of the reasons why ditransitive verbs tested were more problematic for the participants than other types of verbs.

It is of paramount importance to mention that the participants used adequate tense morphology on the verbs in all the groups from the earliest age. This indicates that they can recognize verbs as members of a coherent syntactic category, different from that of nouns (verbs are always inflected for person and tense in Serbian, which is how they differ from nouns), which in turn supports the nativist approach. This strongly speaks against the usage-based account, which suggests that learning is item-based and that very young children are unable to make generalizations. The consistent use of the third person singular verb form by the participants in this study provides evidence that children are able to generalize with verb forms from the earliest age.

5.1. Limitations of the study

The results of this transversal research indicate that children acquire syntactically less complex verbs first. What needs to be said though is that the number of participants in the pilot research was limited. Our initial intention was to test at least three children in each group, starting with 18 months. However, that was impossible, because there were no younger children in the kindergarten. The youngest participant who responded to the stimuli was 2;4 months old. Moreover, we could not control for the gender variable, since we could only test the children whose parents signed the consent form. Therefore, the results obtained should be taken with caution, until a more controlled study with a greater number of participants is conducted. It should also be said that there is a danger of noticing generational differences in transversal studies (Jerković & Zotović, 2010).

Another drawback of the research is the fact that the frequencies of the target verbs in child language could not be explored in detail. A Frequency Dictionary of Child Language (Lukić, 1983) is available in Serbian. However, this frequency dictionary was compiles on the basis of written exams done by children whose age range was from eight to fourteen years. This type of sample is not very suitable for our purposes for two reasons. First, the children were much older than the participants in this research and second, the sample relied only on written sources.

5.2. Implications for future research

The results of the pilot test showed that children who are at a lower stage of speech development have more difficulty producing verbs with complex argument structures (those with a third argument or those which involve a complex syntactic process of derivation from a transitive verb). Children at a lower stage of language development were most successful in producing verbs which show a subject-agent correspondence (transitive and unergative verbs). On the other hand, anti-causatives, which are also one-place predicates, were produced at a much later stage (2;7 months in the pilot test). Successful production of ditransitives increased with the growth of language development as well. However, a larger sample including participants who are at the earliest stage of language acquisition (1;6 months) is needed in order to draw more reliable conclusions.

Since the drawing for the verb *sijati* 'shine' proved to be ambiguous, because it offered many alternatives, it was decided to exclude it in the main research. The imperfective verb *padati* 'fall', which was presented on the drawing with the rainfall, was also not tested, because the participants heard these set phrases every day (*sunce sija* 'the sun is shining' and *pada kiša* 'it's raining'). The perfective verb *pasti* 'fall' was to be kept in the main research instead.

As could be noted in the results section, the production of anti-causative verbs was quite low even in the older groups. As it has previously been pointed out, the results for DAN (3;5), NIK (3;9) and ANA (4;2) for the anti-causative verbs *zatvoriti se* 'close' and *ugasiti se* 'turn off' should be discarded, because the interviewer used a question which urged the children to answer with transitive verbs (What did I do with the door/lights?). In order to prevent making the same kind of mistake with items again, all the questions are to be prepared and written down in advance in the future.

6. Conclusion

The aim of this research study was to examine the order in which verbs with different argument structure are acquired (unergative, unaccusative, anti-causative, transitive and ditransitive verbs), in order to get some insight

into the way children acquire verbs of different complexity. We wanted to make sure that the items were clear enough for the participants, before conducting the main study. A total of twelve participants belonging to four age groups were interviewed, using a verb elicitation task. Although the number of participants was rather limited, significant among-group differences were noted in this study. Participants of the youngest age group produced mainly transitive and unergative verbs (both show a subject-agent correspondence), but they also produced some anti-causative verbs. There were only two ditransitive verbs produced in the first group and there were no anti-causative verbs produced. This tendency continued in the next group, but the participants performed considerably better. Anti-causative verbs were produced for the first time. After this, the production steadily increased across verb types in groups 3 and 4.

In brief, the results show that children at a lower stage of language development have more difficulty producing verbs with a complex argument structure, either those with a third argument or those which involve a complex syntactic process of derivation from a transitive verb. The acquisition of verbs starts with transitive and unergative verbs, followed by unaccusative verbs. The production of ditransitive and anti-causative verbs is delayed.

Finally, the results should be taken with caution, since the number of participants in the study was very limited. It is expected that the results of a larger-scale transversal study with a greater number of participants will confirm these tendencies.

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PRESENTATION MODALITY INTERACTS WITH THE EFFECT OF VISUAL PERCEPTUAL STRENGTH ON WORD PROCESSING [1]

Abstract:The aim of this research was to investigate the effect of visual perceptual strength across abstract and concrete words, as well as its relation to the modality in which the word is presented. Based on Perceptual Symbol Theory and previous findings, we hypothesized that visual perceptual strength will be negatively correlated with processing cost and will have a stronger effect when there is congruency between the presentation modality and the modality by which the concept denoted by the word can be experienced. These predictions were tested on abstract and concrete nouns which can be experienced only by visual perceptual modality. In both word groups the level of visual perceptual strength varied on a continuous scale. All groups wof nouns ere presented both in a visual and an auditory lexical decision task. The results revealed no main effect of visual perceptual strength and an interaction between visual perceptual strength and presentation modality. This interaction revealed that the effect of visual perceptual strength was present only in the visual lexical decision task, as expected. However, the direction of the effect was opposite to the one predicted. Additional analyses located this effect only to the case of concrete words. While the observed results can only partly be interpreted by Perceptual Symbol Theory, they contradict predictions of amodal theories.

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Key words: visual perceptual strength, congruency effect, visual lexical decision, auditory lexical decision, perceptual symbol theory, grounded cognition, concreteness effects, abstract concepts, concrete concepts.

1. Introduction

For a long period of time scientists have been discussing in what way our conceptual knowledge is represented and organized. The theories according to which conceptual representations are amodal have long been dominant in cognitive psychology (Tulving, 1972; Smith & Medin, 1981; Fodor, 1975; Pylyshyn, 1984). According to these theories, sensorimotor experiences are translated into amodal conceptual representations, such as feature lists or a semantic network. These amodal conceptual representations bear no systematic resemblance to perceptual experiences based on which they were formed and they are connected with them arbitrarily (the same way words are connected with the concepts they denote). So, for example, the word *flower* bears no resemblance to the concept of flower which it denotes (thus, for example, flower could be called *grel*, which would not change its characteristics). In the same way, according to the theories of amodal conceptual representation, the amodal representation of the concept of flower bears no systematic resemblance to the perception of that object. Amodal symbols which represent concepts in the absence of perception are stored in a system which is separated from the perceptual system, while these two systems function by different principles (Barsalou, 1999). On the other hand, nowadays there is an increasing amount of evidence in favour of the existence of a modality-specific system where our conceptual knowledge is stored. This idea was proposed for the first time by the Dual-Coding Theory (Paivio, 1991), in which Paivio presumed the existence of verbal and nonverbal symbol systems in which our conceptual knowledge is stored. According to this theory, abstract concepts have only their verbal representation, while concrete concepts are dually coded and they have both their verbal representation and visual, auditory or some other kind of representation within some other modality, depending on the modality by which the concept can be experienced. Nowadays, one of the leading theories, according to which conceptual representations are modality-specific, is the

Perceptual Symbol Theory (Barsalou, 1999). According to this theory, conceptual representations (so-called perceptual symbols) are based on physical (perceptual) experience with what the concept represents, so the concept activation actually implies simulating the concrete experience. Simulating of the concrete experience refers to the reactivation of the patterns of activation which were present during the physical experience with the given concept. According to this theory, perceptual symbols are represented in the same system as the perceptual states which created them.

According to the perceptual symbol theory, perceptual symbols actually represent records of neural activations which underlie perception (Barsalou, 1999). Each type of symbol is stored in the corresponding brain area – visual symbols in the visual area, auditory symbols in the auditory area, proprioceptive symbols in the somatosensory and motor area, etc. Findings in the field of cognitive neurosciences supported this view. Thus, for example, a damage in the visual brain area causes difficulties in processing categories which are specified by visual characteristics such as, for example, the category of birds (Barsalou, 1999). Furthermore, experiments conducted with healthy participants (PET studies) have shown that in the naming task, the visual area is highly active while naming animals, whereas the motor area is highly active while naming concepts from the category of tools (Pulvermüller, 1999). Gonzalez and colleagues (2006) discovered in one of their studies that passively reading words which denoted smells or were smell-related (for example *dill*) led to increased activation in the primary olfactory areas. Similar finding have been demonstrated for the visual domain by Simmons et al. (2007) in a property verification task. Here, deciding about the colour of an object (e.g. *A banana is yellow*) activated the areas in the visual cortex that were activated in the colour perception task (left fusiform gyrus). Finally, studies conducted by Goldberg, Perfetti and Schneider (2006) have shown that the verification of various stimulus characteristics, such as colour, sound, touch and taste, activated the corresponding cortical areas which are related to coding visual, auditory, tactile and gustatory experiences.

Different objects (concepts) in the world around us can be experienced by one or more different senses. The fact that a certain concept (object) can be experienced by a certain sensory modality can be considered to be a characteristic of the given concept, just like its shape, colour or texture.

This characteristic can be called "modality presence" and it is one of the characteristics of concepts which will be studied in this paper. Thus, for example, the concept of rainbow has only one sensory modality – visual, since this concept can be experienced only by sight. The concept of noise can be experienced only by hearing, so it has only auditory sensory modality. On the other hand, some other concepts have a larger number of sensory modalities as they can be experienced by several senses – simultaneously or separately. The concept of rooster, for example, can be experienced by almost all senses – we can see it, hear it, touch it, smell it and even taste it.

In a previous study (Živanović & Filipović Đurđević, 2011), which focused on modality presence (modality specific perceptual strength) as a characteristic of concepts, we examined processing effects of the congruence between the sensory modality through which the concept can be experienced and the sensory modality of word presentation (visual vs. auditory). It was shown that such congruence led to the facilitation of word recognition in the lexical decision task. Words which denoted concepts that could be experienced only by sight were processed faster and more accurately in the visual lexical decision task (in which stimuli were shown visually, on a computer screen), than the words which denoted concepts that could be experienced only by hearing. On the other hand, in the auditory lexical decision task (where stimuli were presented auditorily), words which denoted concepts that could be experienced only by hearing were processed faster than the words which denoted concepts that could be experienced only by sight. This finding was interpretedin the light of the perceptual symbol theory (Barsalou, 1999): a word which represents the given concept activated perceptual simulation of the concept; perceptual simulation of the concept is based on physical experience with the concept, which involved reactivation of the neural pathways which were activated during the experience with the concept. For this reason, words were recognized faster (in the lexical decision task) when they were presented in the modality by which the given concept can be experienced than when they are presented in some other modality. Therefore, this finding presented further evidence in favour of the thesis that conceptual knowledge is stored in a system which is modality-specific, and that conceptual image activation is connected with reactivating the patterns of activation which were present during the experience with the concept. This interpretation is in accordance with a view presented

by Connel and Lynott (2012b) who stated that the process of modality specific perceptual stimulation would incur processing cost within that modality if it occupied attention to the extent that there would be no resourses left for modality specific simulation. Unlike that, if modality specific perceptual stimulation only directed attention without occupying resources (as was the case in Živanović & Filipović Đurđević, 2011), then a facilitation effect would be observed.

The largest number of studies which have provided evidence in favour of modality-specific organization of conceptual knowledge dealt with concrete concepts. Explaining representations of abstract concepts has been a challenge to modality-specific theories for a long time. Abstract concepts are defined as concepts which are not entirely physically or spatially defined (Barsalou & Wiemer-Hastings, 2005) and which, therefore, cannot be experienced by senses, so we could say that they do not have any sensory modalities. The question is how abstract concepts are represented, or to put it more precisely, how their representation is explained by the theories which presume the reactivation of neural pathways which were activated during the perception of concepts. The perceptual symbol theory (Barsalou, 1999) provided an explanation which is based on the representation of abstract concepts via perceptual symbols (just like the representation of concrete concepts). According to this theory, perceptual symbols can represent any aspect of experience, including all five sensory modalities, proprioception and introspection, and not only the experiences which come via senses. Representations for introspective experiences, i.e. perceptual symbols for introspective experiences, are developed in the same way as the representations of physical experiences (Barsalou, 2009), and such perceptual symbols are crucial for the representation of abstract concepts. Namely, abstract concepts are represented by complex simulations which include physical, social and introspective elements. When participants are given a word which denotes an abstract concept, a perceptual simulation of the specific situation in which that concept appears takes place. Both concrete and abstract concepts are always represented within a context, a situation, and not isolated. When abstract concepts are represented, according to modality-specific theories, the aspects which are crucial for a certain abstract concept are selected against the background, i.e. the context of the entire

event, and are mostly represented by perceptual symbols for introspective experiences.

As already mentioned, abstract concepts are defined as concepts which cannot be experienced by senses, which are not physically defined. However, while preparing an experiment for one of the previous researches (Živanović & Filipović Đurđević, 2010), a contradiction in the participants' responses (ratings) was observed. On that occasion, various types of participants' ratings for the words used as stimuli in the experiment were collected. Among other things, the participants were asked to rate the general concreteness of the concepts denoted by the given words, and to rate in what degree the concepts could be experienced by each sense. All ratings were performed on a seven-point scale. Unexpectedly, some words which were rated as abstract during general concreteness rating (score below 4 on the concreteness rating scale), were rated as having a modality on other scales (when the scales were separated by modalities and when participants rated in what degree a concept could be experienced by each sense). In other words, what would traditionally be considered as an abstract word was rated as if it could be experienced by a certain sensory modality, for example, as if it could be seen to a certain degree (so we would say that it has visual modality). Therefore, there was a discrepancy between general concreteness rating and sensory-modality specific rating. A similar finding has been reported by Connell and Lynott (2012). These findings led us to the following question: Is the presence of modalities a categorical variable (it can/cannot be seen, it can/cannot be heard, etc), as we have considered it so far, or is it actually a matter of degree? Our hypothesis was that the presence of modality can be considered to be a continuous variable – something can be seen more or less, more or less clearly, more or less obviously, with more or less difficulty, and that as such it influenced word processing. Something that has been rated as "more visible" (or it is observed by sight more easily) on the rating scale from 1 to 7 will be more quickly and more accurately recognized in the lexical decision task than something that has been rated as less visible or something that cannot be seen. Therefore, we would predict facilitatory effects of visual perceptual strength.

In this paper, we will focus only on the words which can be experienced only by sight in various degrees (starting from 1–it cannot be seen at all to 7 –it can easily be seen), but we will presume that the findings could be

generalized to other senses as well. Thus, the group of words used as stimuli in this research covered the entire range of the concreteness scale (from abstract to concrete words) and the entire range of the visibility scale (from words denoting concepts which could notbe experienced by sight at all and could not be experienced by any other sense, to those denoting concepts which could easily be experienced by sight, but could not be experienced by other senses). Therefore, the presented group of words included abstract and concrete words which could be experienced by sight in various degrees. All words were presented to the participants both in visual modality (in the visual lexical decision task) and in auditory modality (in the auditory lexical decision task). Based on the previous findings (Živanović & Filipović Đurđević, 2009; 2011), it is expected that the contribution of the presence of visual modality (i.e. visual perceptual strength) would be greater in the case of visual stimulus presentation than in the case of auditory presentation. As mentioned, it has been shown that congruence between the modality which the concept has and the modality inwhich the word denoting the given concept is presented facilitated word processing. Visual presentation of words would highly activate the visual area, which would enable the fastest recognition of words denoting concepts with visual sensory modality, the perceptual symbols of which are stored in this area. Therefore, according to the Perceptual Symbol Theory, a word which refers to a certain concept would activate the perceptual symbol of that concept which is stored in a specific brain area. If there is an overlap of neural pathways by which the information about the concept is received and of the pathways which would be activated by activating the perceptual symbol, the word recognition would be faster. This would be possible due to the fact that there would be no specific engaging of modality-specific attention (that would leave no resources for perceptual simulation), but only modality-specific attention directing (Connel & Lynott, 2012b). Thus, it could be expected that a higher degree of presence of a congruent modality would have greater influence, i.e. that a higher degree of presence of a congruent sensory modality would enable easier and faster activation of the perceptual symbol of that concept. Therefore, we predicted that facilitatory effect of visual strength would be stronger for visually presented words than for words presented auditorilly (i.e. we predicted interaction between presentation modality and visual perceptual strength).

To summarize, based on theories of grounded cognition (e.g. Barsalou, 1999), we predicted facilitatory processing effects of visual perceptual strength. Crucially, we predicted interaction between visual perceptual strength and presentation modality, with the effect of visual perceptual strength being strenger for visually presented words. This interaction could not be accounted for by amodal theories (e.g. Fodor, 1975), which presume that concepts are translated into amodal symbols which bear no resemblance to perceptual experiences based on which they have been formed and which are stored in a system which is separated from the perceptual system. Hence, according to these theories, the characteristics of the concepts should in no way influence processing of words that denote them, or the modality in which those words are presented.

2. Experiment

Our research consisted of two phases. In the first phase, a norming study was conducted in order to collect subjective ratings of several characteristics of the stimuli. In the second phase, we conducted visual and auditory lexical decision task experiments.

2.1. Method

2.1.1. Participants

One hundred and thirty-two participants took part in the first phase of the experiment (21 rated general concreteness, 24 rated familiarity, 86 rated per-modality perceptual strength). They were all native speakers of Serbian, either students at the Department of Psychology at the Faculty of Philosophy in Belgrade or final year students at the Secondary Medical School in Požarevac. Additional 56 participants took part in the experiments (29 in the visual lexical decision task and 27 in the auditory lexical decision task). They were all students at the Department of Psychology at the Faculty of Philosophy in Novi Sad and Serbian native speakers with normal hearing and normal, or corrected to normal, vision.

2.1.2. Stimuli

We selected 189 Serbian nouns (Appendix A) in the nominative singular and 189 pseudowords to be presented in the experiments. In the first phase of the research we collected concreteness, familiarity, and per-modality perceptual strength ratings for the full set of selected nouns.

General concreteness ratings were collected by instructing the participants to say to what degree it was possible to experience what the word denotes by the senses (to what degree something could be seen, heard, smelt or touched), i.e. they were asked to rate to what degree the given concept was concrete or abstract (number one meant that the word denotes something that cannot be experienced by the senses, e.g. *patriotism*, and number 7 meant that the word denotes something which can easily be experienced by senses, e.g. *rooster*). The words in the questionnaire were in alphabetical order. General concreteness ratings were collected from 21 participants.

Familiarity ratings were provided by 24 participants. When rating the familiarity of a word, the participants were asked to estimate how familiar they were with the word, i.e. how often they had come across the given word (number 1 meant that they were not familiar with the word, i.e. that they had never come across it before, while number 7 meant that participants had often come across the given word). The words were arranged in alphabetical order in the questionnaire.

Concreteness by modalities was assessed by asking the participants to estimate to what degree the concept denoted by the word can be experienced by one particular sense (for example, to what degree it was possible to see something); number 1 meant that the word denotes something which cannot be experienced by the given sense (e.g. *chirp* if the possibility of experiencing by sight is rated), and number 7 meant that the word denotes something that can be experienced by the given sense very easily (e.g. *peach*). This procedure resembled the one previously used (Connel & Lynott, 2012a; Lynott & Connell, 2013; Živanović & Filipović Đurđević, 2010; 2011). Ratings were performed for sight, hearing, smell, taste and skin senses (skin senses included touch, pain, warmth, but also various somatosensory information). The questionnaires were designed based on the Latin square design, so that one participant rated the presence of only one modality for one word (but all participants saw all words and rated all modalities). Therefore, there were five different groups of questionnaires (dif-

ferent groups of words for different modalities) with three different random sequences within each group of questionnaires.

The nouns presented in the experiment were selected so that they covered the entire range of the general concreteness scale (from abstract nouns, for which it was established based on the participants' ratings that they cannot be experienced by the senses, to concrete nouns) and the entire range of the scale of visual modality presence (from concepts which cannot be experienced by sight, e.g. *idea*, *thought*, to concepts which can easily be experienced by sight, e.g. *cloud*, *colour*). The nouns which were analyzed in this research were those that were rated as unexperienceable by other senses (i.e. as concepts which cannot be heard, smelt, touched, or tasted since they had lower [M<4] values on the scales on which their potential to be experienced by other senses was rated). Therefore, the stimuli used were abstract nouns and nouns denoting concepts which can only be experienced by sight to various degrees.

For the needs of the auditory lexical decision task, stimuli were recorded using a computer and specialized software – *Praat* (Boersma & Weenink, 2009). During the recording, the stimuli were pronounced by a male adult in the sentence "*Say the stimulus, please*." The stimuli were recorded in sentence context in accordance with previous research, in which the auditory lexical decision task was used (Slowiaczek & Pisoni, 1986), and in order to avoid too large word length when it is pronounced in isolation and to control the variation in the length of word pronunciation. After that, using *Praat* computer program, the words were extracted from their carrier sentence and presented to participants in the auditory lexical decision task.

Pseudowords were designed by replacing one (usually final) phoneme/grapheme in a noun so that the word would lose its meaning. Nouns other than the nouns used as stimuli in the experiment were used for the purpose of designing the pseudowords. The pseudowords were similar to words in their length (the number of letters) and the length of pseudoword pronunciation (in milliseconds).

2.1.3. Design

The criterion variables were the reaction time expressed in milliseconds and the percent of errors. The predictor variables were the type of task

(the task of visual/auditory lexical decision; this predictor was manipulated between participants, but within stimuli) and the degree of presence of visual modality, or visual perceptual strength (expressed by the participants' rating on a seven-point scale). The control variables were word length (expressed in the number of graphemes), the logarithm of lemma frequency (Kostić, 1999), familiarity (subjective frequency), general concreteness and the number of orthographic neighbours (Coltheart, Davelaar, Jonasson & Besner, 1977). Additionally, the length of word pronunciation was measured (in milliseconds) in the auditory lexical decision task; the correlation between this variable and word length measured in the number of letters was high ($r=0.86$, $p<0.01$), so for this reason, the length of word pronunciation was excluded from the analyses and the word length measured in the number of letters was used to represent this group of variables.

2.1.4. Procedure

Two tasks were used in the experiment – the visual lexical decision task and the auditory lexical decision task. In the visual lexical decision task, stimuli were presented visually, on a computer screen. The presentation of each stimulus was preceded by a fixation point in the duration of 1500 ms. The stimulus presentation time was limited to 1500 ms. The responses were given by pressing a button on the response box, and the participants gave their responses using both hands (the right button if the presented stimulus was a word, and the left one for the pseudowords if the participant was right-handed and vice versa for left-handed participants). If the participant did not respond to the presented stimulus in the time period of 1500 ms, he would receive the following feedback: "Try to answer a little faster!", and if a participant made a mistake, he would receive the following feedback: "You have made a mistake, try again!" In both cases, the same stimulus was presented again. Before the beginning of the experiment, the participants were given 8 practice trials. The examples presented during the practice were not included in the analyses.

In the auditory lexical decision task, the stimuli were presented auditorily, binaurally, via headphones. The responses were given by pressing a button on the response box using both hands, in the same way as in the visual lexical decision task. The participants received a visual feedback in case they made a mistake ("You have made a mistake, try again!") and in

case they failed to respond within the set time interval ("Try to answer a little faster!"). In both situations the stimuli were presented again. The presentation of each stimulus was preceded by an empty screen in the duration of 1000 ms (the empty screen was introduced in order to avoid a situation in which the feedback from the previous trial stays on the screen the entire time, and to make a pause between the trials, i.e. to avoid stimuli going one after another too fast), and after it a sound signal in the duration of 500 ms announced the stimulus. The maximum duration of stimulus presentation with the time for response was limited to 3000 ms. The reaction time was measured from the onset of the stimulus pronunciation to the moment of pressing a response button. In this task, the participants were also given 8 examples to practice before the beginning of the experiment. The examples presented during the practice were not included in the analyses.

Specialized software (SuperLab Pro 2.0; Cedrus, 2001) was used for the manipulation of independent variables and the measurement of dependent variables.

3. Results and discussion

Prior to the analyses, we excluded all of the pseudowords, as well as the items with above 25% error rate, and items that received <4 average rating for the possibility of being heard, smelled, tasted, or touched (based on collected norms). After this, there were 130 words that were included in the analysis. None of the participants were excluded, as the overall accuracy was high (<10% error rate per participant). Next, we considered the possibility of collinearity among our predictors by calculating Kappa coefficient (Belsley, Kuh & Welsch, 1980) and pairwise correlations between predictors. Although the Kappa coefficient was formally within the medium range (≈24, i.e. <30), we found that the correlation between general concreteness and visual perceptual strength was very high ($r=0.91$, $p<0.05$). This was not surprising, as we selected our stimuli trying to make visual perception strength as diverse as possible, while keeping other modality-specific strengths as low as possible. This led to variance in concreteness being dominantly attributable to visual perceptual strength. One possibility to deal with such collinearity would be to apply principal components analysis, as suggested by Wurm and

Fisicaro (2014). However, this would prevent us from being able to attribute the effects to visual perceptual strength *per se*. With this in mind, we decided to apply another strategy (as suggested by Baayen, 2008) not to include concreteness in the set of predictors, that is to include only one of the two highly correlated predictors, in this case – visual perceptual strength. We analyzed our data using R statistical software (http://www.r-project.org/) and mgcv package (Wood, 2006; 2011). Additionally, prior to the analyses, we transformed the predictors by centering them and deviding them by standard deviation, as suggested by Gelman and Hill (2007). We fitted mixed-effect generalized additive models to individual reaction times (using Gaussian as the underlying response distribution). In order to control for the possible effects of the outliers, we refitted each model after excluding the points with residuals that exceeded the range of -2.5/+2.5 standard units. As the structure of results after refitting resembled that of the original ones, we reported only the results of refitted model (Table 1).

Table 1. Coefficients from the generalized additive model fitted to reaction time.

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	6.751	0.019	361.183	<0.001
Presentation modality: VLD	-0.237	0.025	-9.365	<0.001
Trial (order of presentation)	-0.005	0.004	-1.197	0.231
Word length in graphemes	0.014	0.005	2.670	<0.01
(log) Lemma frequency	-0.019	0.005	-3.675	<0.001
Word familiarity	-0.031	0.005	-6.295	<0.001

Smooth terms:

	edf	Ref.df	F	p-value
Factor smooth for Visual perceptual strength at the level of ALD	1	1.001	3.815	0.051
Factor smooth for Visual perceptual strength at the level of VLD	7.473	8.3	5.487	<0.001
by-Participant factor smooths for Trial	162.922	502	5.847	<0.001
by-Item random intercept	102.377	125	4.805	<0.001

N=6851; ML=-2943

In addition to random effects of items, and smoothing of order of trial presentation for each participant separately, our results revealed significant effects of several control variables. As expected, word length in graphemes had inhibitory effect, whereas (log) lemma frequency and word familiarity facilitated processing. Importantly, we observed a significant effect of visual perceptual strength, but only for visually presented words, that is, only in visual lexical decision task (VLD).

The observed visual perceptual strength by presentation modality interaction is in accordance with our predictions. However, the predicted effect of visual perceptual strength for auditorilly presented words was not observed. As can be seen in Table 1 and Figure 1 (left panel), there was a linear facilitatory trend, but this effect did not reach significance. At the same time, we predicted even stronger facilitation for visually presented words. However, as illustrated in Figure 1 (right panel), this effect was highly non-linear preventing us from clearly concluding about its trend.

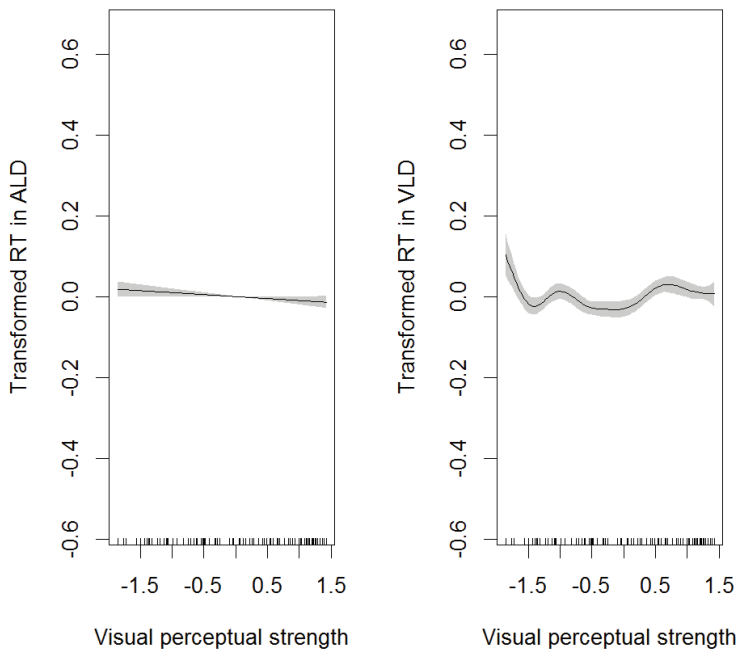

Figure 1. Partial effects of visual perceptual strength on reaction time observed in auditorylexical decision task (left panel) and visual lexical decision task (right panel).

4. General discussion

The registered result pattern does not fully agree with the findings of our previous research (Živanović & Filipović Đurđević, 2010; 2011) and it does not fully match our initial hypotheses. We did not observe a facilitatory effect of visual perceptual strength regardless of the presentation modality – although facilitatory in trend, this effect was not significant for auditorily presented words. Even more so, for visually presented words, although significant, the effect was highly non-linear, and not clearly facilitatory as we predicted. However, we did observe the predicted visual perceptual strength by presentation interaction, as the effect of visual perceptual strength was significant only for visually presented words.

Previous research which focused on studying the presence of sensory modalities (Popović, Živanović & Filipović Đurđević, 2009; Živanović & Filipović Đurđević, 2010; 2011; Popović Stijačić & Filipović Đurđević, 2015) has confirmed the hypothesis that the presence of a certain sensory modality can be considered to be one of the characteristics of a concept, just like its colour, shape or texture. According to amodal theories of the organization of our conceptual knowledge (Tulving, 1972; Smith & Medin, 1981; Fodor, 1975; Pylyshyn, 1984), our sensorimotor experiences are translated into amodal conceptual representations, which bear no systematic resemblance to perceptual experiences based on which they were formed and which are stored in a system which is separated from the perceptual system. Therefore, perceptual characteristics of concepts and the way in which the words which denote the concepts are presented should in no way influence the processing of the words which represent those concepts. The interaction which was registered in this research poses a challenge to amodal theories.

On the other hand, modality-specific theories (Barsalou, 1999) presume that perceptual characteristics of concepts have a significant influence on the formation of conceptual representations. According to these theories, conceptual representations (perceptual symbols) are stored in the same system as the perceptual experiences based on which they were formed. Consequently, the presence or absence of such characteristics and the presentation mode of the words which represent the concepts should influence word processing. The interaction between the visual perceptual strength and the stimulus presentation mode is expected according to modality-specific

theories, since they presume that the overlap (or the absence of it) of the neural pathways which were activated during the perception of words and the ones which should be activated by activating the perceptual symbols of those concepts will influence the processing of the words which represent the concepts. The problem which arises due to the findings of this research (even if we try to explain them by modality-specific theories) is the trend-masking nonlinearity of the observed effect. Namely, according to modality-specific theories, a higher degree of visual perceptual strength should facilitate word processing in the case of modality congruence (i.e. in the visual lexical decision task), since the perceptual symbols of the concepts which have visual modality are stored in the visual zone, which is highly active during the visual lexical decision task. The overlap of neural pathways which were activated in the task in which the stimuli were presented to the participants visually and the neural pathways which were activated by activating the perceptual symbols of the concepts which the words represent should facilitate word processing. However, we were not able to derive a clear conclusion regarding the trend of the effect of visual perceptual strength fof visually presented words, as the effect was highly nonlinear. One possible explanation could be that the effect that was observed for concrete words (Živanović & Filipović Đurđević, 2011) does not apply to the full range of concreteness scale, namely that it does not apply to abstract words. As previously suggested, the representation of abstract words poses a challenge for theories of embodied cognition (e.g. Dove, 2009; 2015). Our results did not corroborate our expectation of continuity, and suggested that processes that were observed for concrete words might not be transferable to the full range of the abstract-concrete continuum. Some previous studies also suggested a discontinuity of this scale (Connel & Lynnott, 2012).

While our results pose a challenge for theories of amodal representation, they leave open the question of continuity between abstract and concrete words, and call for further investigation.

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Appendix A. Stimuli and collected ratings

Word	Visual perceptual strength	Auditory perceptual strength	Olfactory perceptual strength	Gustatory perceptual strength	Tactile perceptual strength	Concreteness	Familiarity	Word length in graphemes	Lemma frequency	Coltheart N
ZENIT	3.67	1.47	1.17	1.19	1.24	2.86	3.42	5	14	0
NEBO	6.63	1.00	1.65	1.47	1.33	4.19	6.00	4	2818	4
KOMETA	5.53	2.12	1.35	1.22	1.69	4.05	2.96	6	11	2
BOJA	6.71	1.00	2.12	1.94	1.75	5.48	6.21	4	830	18
OSEKA	5.67	2.94	2.24	1.12	2.47	4.62	3.42	5	24	4
TEKST	7.00	4.53	1.28	1.13	1.94	4.57	5.71	5	87	1
TUFNA	6.71	1.00	1.28	1.56	2.18	4.81	3.25	5	0	1
FLEKA	6.75	1.12	2.65	2.11	3.19	5.29	4.54	5	2	3
SUMRAK	6.59	1.44	1.44	1.41	1.47	4.14	4.42	6	187	0
INTERNET	5.24	2.00	1.06	1.00	1.31	2.62	6.79	8	0	2
ODSJAJ	6.06	1.19	1.00	1.06	2.53	4.48	3.88	6	67	1
MEHANIZAM	5.13	3.47	2.41	1.12	2.28	3.14	4.04	9	19	0
BRIGA	3.35	3.00	1.41	1.39	2.38	2.57	6.13	5	264	2
POLET	4.94	2.73	1.82	1.59	2.59	2.76	3.88	5	83	6
SREĆA	5.24	4.67	1.44	1.82	2.41	3.24	6.46	5	1011	5
UMOR	3.88	3.12	1.78	1.25	4.76	2.81	5.88	4	232	6
ANALIZA	3.76	2.38	1.24	1.11	3.06	1.76	5.92	7	54	0
OČAJ	4.61	2.69	1.06	1.59	2.47	2.33	4.33	4	73	4
PRAVAC	5.00	1.13	1.12	1.18	2.24	2.95	5.58	6	208	6
IDEAL	2.12	2.12	1.24	1.22	1.25	1.62	4.67	5	46	0
MISAO	1.25	3.24	1.06	1.71	1.94	1.67	5.52	5	1163	0
TEORIJA	2.25	5.88	1.00	1.06	1.24	1.67	5.96	7	34	0
POŠTOVANJE	3.61	2.94	1.18	1.24	2.00	2.05	5.79	9	53	0

PAMET	2.61	2.69	1.00	1.12	1.35	1.81	6.13	5	40	2
ŠANSA	1.88	2.06	1.50	1.06	1.35	1.86	6.00	5	43	0
UGLED	2.65	2.00	1.39	1.19	1.88	2.19	5.25	5	42	2
KVADRAT	6.69	1.00	1.12	1.18	3.17	4.24	4.54	7	20	0
KRETANJE	6.63	4.76	2.18	1.41	5.67	3.29	5.29	7	86	0
POGLED	6.00	1.25	1.12	1.35	2.29	3.19	5.75	6	1039	1
GEN	1.76	1.24	1.00	1.11	2.00	2.00	4.75	3	0	8
PLAVETNILO	6.29	1.25	1.12	1.71	1.18	3.90	3.25	10	44	0
HRABROST	3.59	2.59	1.53	1.11	1.47	2.00	5.83	8	75	0
PREZIR	4.06	3.89	1.25	1.47	2.12	2.67	4.42	6	22	0
ČEŽNJA	2.41	2.12	1.76	1.56	2.13	2.24	4.46	5	414	0
NARAV	3.06	3.29	1.24	1.35	1.78	2.33	4.92	5	14	2
ŽIVOT	4.06	3.53	2.94	2.19	3.82	3.14	6.58	5	3423	2
SAVET	1.76	6.00	1.25	1.35	1.59	2.43	5.91	5	1	6
OBEĆANJE	1.56	5.12	1.06	1.35	1.61	1.62	5.71	7	70	0
SVITANJE	6.88	1.94	1.88	1.35	1.71	4.19	4.83	7	233	0
DUGA	6.71	1.00	1.06	1.17	1.00	4.10	3.79	4	180	13
SATELIT	5.71	1.56	1.06	1.24	1.71	3.76	4.00	7	10	0
HORIZONT	5.47	1.18	1.24	1.06	1.06	3.33	3.71	8	99	0
DAN	6.47	2.59	3.06	1.17	1.19	4.19	6.75	3	5758	15
NASLOV	6.44	1.47	1.18	1.00	1.22	4.24	5.50	6	61	1
SVEMIR	4.94	1.22	1.31	1.18	1.41	2.90	4.26	6	96	0
MRLJA	6.81	1.00	2.41	2.24	3.28	4.81	4.25	4	81	2
NATPIS	6.94	1.35	1.00	1.00	1.44	4.48	5.21	6	53	0
MIMIKA	6.31	1.41	1.06	1.18	3.39	3.67	3.17	6	5	0
LET	6.19	3.65	1.82	1.18	3.78	3.67	4.17	3	344	19
BRZINA	4.59	3.94	1.53	1.33	2.63	3.90	6.17	6	92	3
CIKLUS	2.35	2.00	1.88	1.28	2.56	2.00	5.04	6	35	0
ELAN	2.76	2.41	1.47	1.22	1.63	2.24	3.67	4	25	10
LJUBOMORA	4.88	3.65	1.24	1.88	3.00	2.76	5.63	8	10	0
ZANOS	2.59	3.29	2.67	1.63	2.59	2.62	5.39	5	278	2
RAZVOJ	4.59	1.44	1.19	1.59	2.18	2.62	5.96	6	214	2
RADOST	5.41	5.56	1.50	1.71	2.65	3.05	6.13	6	1146	3
SEOBA	5.24	2.67	1.06	1.41	1.47	3.05	3.92	5	24	2

ZNANJE	3.35	4.88	1.50	1.44	2.47	2.62	6.33	5	153	0
MAŠTA	2.00	2.53	1.47	2.24	2.11	2.00	5.42	5	212	6
PONOS	3.94	2.31	1.35	1.12	1.71	2.14	5.63	5	129	3
PAMĆENJE	1.78	1.63	1.35	1.24	1.63	2.38	6.17	7	37	0
POJAM	3.67	3.19	1.12	1.29	1.41	1.81	5.25	5	66	3
SLUTNJA	1.88	2.67	1.31	1.29	2.24	1.86	4.71	6	264	0
USLOV	1.71	4.53	1.06	1.06	1.12	1.71	6.17	5	422	0
TROUGAO	6.88	1.12	1.00	1.06	2.06	4.43	4.58	7	11	0
TRIK	4.71	2.71	1.39	1.13	2.41	3.19	4.08	4	7	5
TRAG	6.53	1.82	3.22	1.63	2.82	4.48	4.63	4	623	9
DINOSAURUS	5.53	2.41	2.88	1.39	2.44	3.71	3.13	10	0	0
ŠARENILO	7.00	1.24	1.61	1.44	2.47	4.57	4.33	8	8	0
PRESTIŽ	2.88	1.89	1.38	1.53	2.12	2.24	4.17	7	9	0
SIGURNOST	3.41	2.83	1.38	1.71	2.65	2.14	5.50	9	58	0
ISHOD	3.35	2.53	1.35	1.22	1.33	2.71	4.75	5	19	1
OBUKA	3.25	2.47	1.53	1.00	1.61	2.43	4.67	5	26	5
ŽUDNJA	2.65	3.53	2.39	1.75	3.24	2.67	4.67	5	229	0
OPROŠTAJ	3.44	4.38	1.29	1.18	2.88	2.10	4.88	8	82	0
ZAHVALNOST	3.13	5.65	1.44	1.19	2.25	2.05	5.58	10	42	0
JUTRO	6.29	3.29	4.35	1.78	1.25	4.00	6.42	5	1289	0
MUNJA	6.13	3.82	1.47	1.24	2.33	4.24	4.67	4	216	8
SVETLOST	6.82	1.11	1.44	1.35	2.63	4.71	5.54	8	667	0
FATAMORGANA	4.18	1.29	2.18	1.44	1.56	2.52	2.50	11	5	0
NOĆ	6.81	1.82	2.53	1.53	2.44	4.29	6.33	3	4334	7
SENKA	6.71	1.00	1.13	1.06	1.31	3.90	4.75	5	1209	5
VASIONA	3.18	1.59	1.06	1.06	1.00	2.62	3.42	7	48	1
OTISAK	6.33	1.19	1.35	1.53	4.88	4.67	3.46	6	43	2
TAMA	6.65	1.35	1.50	1.25	1.41	4.00	4.83	4	823	18
ISKRA	5.35	2.12	1.75	1.44	3.19	3.71	3.04	5	136	0
LEPOTA	6.69	2.00	2.25	2.41	3.89	3.43	6.42	6	509	0
DALJINA	5.29	3.24	2.00	1.17	2.00	3.57	5.54	6	675	1
PATNJA	4.78	3.56	1.12	1.82	3.35	2.71	5.08	5	232	1
POROK	4.33	1.60	2.71	3.82	2.50	2.95	4.50	5	24	3
TUGA	3.94	4.71	1.67	1.50	3.47	2.38	4.83	4	1326	15

ZDRAVLJE	3.47	2.41	2.83	1.81	4.88	2.95	6.33	7	234	0
UŽITAK	3.24	4.06	3.78	2.75	4.06	3.10	5.13	6	6	0
LJUTNJA	5.00	4.47	1.12	1.94	3.39	2.90	5.50	5	13	0
SMER	5.53	1.78	1.13	1.24	2.06	2.62	5.13	4	52	9
PRAVDA	2.61	2.38	1.18	1.53	2.12	1.86	6.00	6	140	1
MORAL	2.19	1.71	1.18	1.41	1.11	1.67	5.13	5	24	5
PORAZ	3.44	2.69	1.29	1.53	1.94	2.00	5.17	5	126	1
IDEJA	1.88	3.59	1.35	1.11	1.13	1.90	6.33	5	110	0
POVOD	2.11	2.38	1.00	1.12	1.41	2.05	5.38	5	100	6
STANJE	4.00	3.06	2.25	1.53	3.35	2.62	5.46	5	399	0
ZAKON	2.41	5.24	1.11	1.19	1.59	2.00	5.25	5	431	3
KRUG	6.63	1.00	1.24	1.18	3.17	4.05	5.21	4	633	3
TREPTAJ	5.88	3.18	1.06	1.25	4.29	4.33	3.75	7	30	1
CIFRA	6.82	2.53	1.00	1.00	1.00	3.62	4.71	5	24	2
BLEDILO	6.65	1.00	1.06	1.11	2.94	4.19	4.13	7	27	1
MODRICA	6.94	1.06	1.29	1.12	6.50	5.24	4.67	7	12	4
PREVARA	3.76	3.39	1.56	1.71	2.06	2.24	5.50	7	38	2
ZABORAV	1.41	1.59	1.56	1.25	2.18	1.62	5.08	7	231	0
KRIZA	2.53	2.00	1.35	1.47	1.72	1.95	5.58	5	71	2
SLOGA	3.94	2.72	1.25	1.47	1.35	2.52	4.67	5	22	5
ISKAZ	2.82	5.38	1.06	1.11	1.44	3.62	4.04	5	24	2
ISTINA	3.71	4.59	1.76	1.33	2.19	2.52	6.00	6	375	2
POUKA	2.61	3.56	1.29	1.41	1.47	1.95	5.00	5	10	2
VEČE	6.24	2.29	3.72	1.13	1.24	4.05	5.54	4	569	4
OBLAK	6.81	1.12	2.00	1.47	1.56	4.48	5.33	5	1565	2
MAGLA	6.31	1.12	2.81	2.06	2.56	4.14	3.83	5	631	2
OSMEH	6.83	3.69	1.18	1.59	4.12	5.52	6.21	5	720	1
PEJZAŽ	6.89	1.31	2.41	1.53	1.82	4.57	4.21	6	107	1
PANORAMA	6.28	1.38	1.24	1.06	1.35	4.10	3.33	8	15	0
KOSMOS	2.65	1.18	2.00	1.06	1.25	2.48	3.04	6	2	1
ZRAK	5.12	1.18	1.56	1.31	3.12	3.86	4.33	4	3	10
LAVA	6.94	4.88	3.53	2.24	6.00	4.76	2.96	4	35	13
MESEČINA	6.50	1.18	1.35	1.18	1.56	4.05	4.33	8	424	0
STARENJE	5.00	1.44	1.63	1.59	3.71	3.14	5.42	7	3	0

BLIZINA	5.65	3.65	3.00	2.28	3.81	3.90	5.79	7	163	1
NEMIR	4.06	3.82	1.35	1.47	3.61	2.57	4.54	5	390	2
PAD	5.72	4.81	1.24	1.35	5.41	4.52	4.29	3	147	20
ZALJUBLJENOST	4.88	3.65	2.33	1.75	4.82	3.14	6.21	11	4	0
BOLEST	5.06	2.18	3.00	3.00	5.06	4.10	5.75	6	222	0
IZNENAĐENJE	4.47	4.06	1.76	1.28	1.93	3.14	6.00	10	84	0
POJAVA	5.83	3.75	2.06	1.35	2.06	2.86	5.29	6	142	2
ZAMOR	3.59	3.06	1.50	1.31	4.76	2.95	5.33	5	13	7
LJUBAV	2.81	3.29	1.94	2.76	5.06	2.95	6.38	5	2365	1
MOTIV	2.13	1.65	1.06	1.06	1.33	1.71	5.50	5	71	0
PRETPOSTAVKA	1.47	3.89	1.38	1.18	1.82	1.81	5.46	12	19	1
NAGON	3.19	2.41	1.59	1.65	3.89	2.14	5.04	5	24	4
PRKOS	4.41	3.67	1.19	1.59	2.24	2.81	4.96	5	60	0
STEPEN	2.41	1.78	1.06	1.29	2.53	2.10	4.88	6	106	1
LINIJA	6.50	1.00	1.06	1.24	3.33	4.14	5.13	6	6	5
VREME	3.65	1.76	2.33	1.19	2.35	2.14	6.00	5	2376	1
MANIRI	4.44	3.94	1.18	1.24	2.56	3.05	4.13	6	7	1
MLAZ	6.69	5.94	2.75	3.00	6.50	4.76	4.00	4	164	7
CRVENILO	6.88	1.00	1.29	1.56	4.69	4.71	4.58	8	9	1
PLAMEN	6.72	1.63	4.88	2.82	6.82	5.62	4.38	6	464	3
ODLUKA	2.83	4.06	1.18	1.24	1.35	1.67	5.54	6	446	1
DOKAZ	4.71	2.35	2.24	2.06	2.25	3.24	4.75	5	92	0
MRŽNJA	3.94	3.53	1.50	1.94	3.22	2.76	4.79	5	320	0
SLUH	1.13	4.67	1.06	1.29	1.47	2.33	5.42	4	98	3
LAŽ	2.13	5.06	1.47	1.59	1.89	2.48	5.26	3	192	9
INTERPRETACIJA	4.00	5.59	1.00	1.00	1.94	2.10	4.67	14	19	0
PRENOS	3.94	4.28	1.25	1.18	2.88	2.62	5.21	6	43	1
PRASKOZORJE	5.78	1.50	2.29	1.59	1.24	2.80	2.17	11	47	0
PLANETA	4.71	1.25	1.59	1.59	2.24	3.52	4.25	7	47	1
SUNCE	6.88	1.00	1.38	1.53	5.06	5.10	6.08	5	2984	2
PLIMA	6.06	2.56	2.71	1.41	2.47	4.57	3.33	5	140	3
BLJESAK	6.65	1.47	1.18	1.17	1.44	4.95	3.83	6	133	1
MRAK	6.81	1.41	1.76	1.59	1.72	4.19	5.83	4	1307	11
VARNICA	6.12	3.59	3.33	1.25	4.69	4.71	4.33	7	72	3

PANTOMIMA	6.39	1.31	1.00	1.06	2.41	3.95	3.25	9	6	0
RUPA	6.82	1.33	1.31	1.88	5.25	4.81	5.17	4	80	18
POMRAČINA	5.94	1.00	1.35	1.00	1.71	4.05	3.75	9	53	0
PROSTOR	6.81	2.17	2.06	1.47	4.35	4.05	5.50	7	398	0
UŽIVANJE	4.29	4.35	3.33	2.63	4.35	3.48	5.92	7	19	0
OPREZ	3.56	2.31	1.24	1.53	2.00	2.05	4.21	5	19	0
SILA	3.41	2.41	1.38	1.94	3.59	2.95	5.13	4	25	13
STRAH	5.00	4.44	1.50	1.53	3.41	3.00	5.46	5	3	1
POGODAK	5.44	3.56	1.12	1.41	3.29	3.52	5.29	7	6	1
RAST	5.35	1.22	1.13	1.71	3.12	3.19	5.38	4	46	6
POROD	4.94	2.94	1.71	1.59	3.88	3.57	3.83	5	16	4
GREH	2.00	2.47	1.65	2.17	1.94	1.52	5.00	4	194	1
DEMOKRATIJA	2.35	2.06	1.00	1.00	1.31	1.33	4.75	11	186	1
NAUKA	2.13	2.41	1.12	1.41	1.00	1.86	6.08	5	116	1
IZDAJA	3.35	3.24	1.59	1.17	2.25	2.19	4.79	6	67	0
OSUDA	3.44	5.07	1.41	1.47	2.94	2.43	3.75	5	21	4
RAZUM	2.53	3.61	1.31	1.53	1.31	2.33	5.92	5	64	0
SVRHA	2.00	1.94	1.13	1.18	1.00	1.86	5.33	5	114	1
TAČKA	6.71	1.00	1.11	1.13	2.18	3.95	6.04	5	2	4
SPOT	6.53	3.61	1.13	1.35	1.29	5.24	4.96	4	0	7
POKRET	6.39	4.19	1.76	1.53	5.59	3.81	5.63	6	365	1
TUNEL	6.82	2.06	3.50	1.13	2.76	4.95	4.21	5	98	0
PROVIDNOST	5.35	1.00	1.13	1.24	1.71	3.57	4.30	10	2	1
UZROK	3.06	3.18	1.44	1.63	1.71	2.00	5.67	5	63	0
ŽELJA	2.71	4.41	2.83	1.63	2.47	2.14	6.50	4	795	4
GUBITAK	2.88	2.47	1.41	1.17	3.00	2.24	5.17	7	85	0
METOD	2.06	2.12	1.06	1.06	1.22	2.05	5.17	5	40	1
UTEHA	2.47	4.94	1.44	1.19	3.18	2.43	5.08	5	170	1
TAJNA	2.24	5.47	1.67	1.25	1.88	2.00	6.00	5	511	8
UVREDA	3.06	6.18	1.33	1.31	2.31	2.52	5.04	6	43	0

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A QUEST FOR SOURCES OF PERCEPTUAL RICHNESS: SEVERAL CANDIDATES[1]

Abstract: In this research we present a norming study and lexical decision experiment on 200 Serbian nouns that were rated for general concreteness and for modality-specific concreteness. For the first time, we present modality-specific concreteness ratings that were obtained separately for the possibility to experience and the actual sensory experience. Based on modality-specific ratings several integrative measures of concreteness were derived. We looked at relations among the collected measures and tested for the predictive power regarding general concreteness rating and processing time. In addition to demonstrating overall relatedness of various measures of concreteness, our results suggest the advantage of modality-specific concreteness measure over and above that of concreteness as traditionally operationalized. This is in accordance with some previous research and goes in line with Embodied Cognition accounts. However, the very measures that were the best predictors of concreteness and reaction time in our research are not the measures that were the best predictors in previous research, pointing to the need for mega-studies or larger datasets.

Key words: concreteness, sensory modalities, modality-specific concreteness rating, processing

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1.Introduction

The organization of semantic knowledge has long been the subject of scientific inquiry. One of the main topics within this area has been the organization of concepts in long-term memory. Numerous research aiming at understanding neural bases of conceptual knowledge led to at least two global insights. On the one hand, they pointed to the significance of category-based organization. This was evident both in occurrence of category-specific agnosias (Lyons, Hanley & Kay, 2002; Miceli, et al. 2000; Samson & Pillon 2003; Shelton, Fouch & Caramazza, 1998; Warrington & McCarthy, 1983; Warrington & Shallice, 1984) and mapping from various categories to specific brain areas (Chao, Haxby & Martin, 1999; Martin & Chao, 2001). On the other hand, previous studies revealed the importance of semantic features in the organization of knowledge. Again, findings from lesion studies converged with those from intact brain imaging. For example, there have been reports on patients with impaired visual knowledge of objects and preserved motor information (Lambon-Ralph, Howard, Nightingale & Ellis, 1998). Along the same line, it has been found that semantic features map onto distinct regions of intact brains (some authors even claimed that the effect of categories can be reduced to that of semantic features). For example, processing of verbs activates areas in premotor cortex that is also activated while performing actions denoted by those verbs (Andres, Finocchiaro, Buiatti & Piazza, 2015; Hauk, Johnsrude & Pulvermuller, 2004; Pulvermuller, 2005). Similarly, Golberg, Perfetti, and Schneider (2006) demonstrated that the task to verify modally specific features of objects denoted by printed words activated exact brain areas that are known to be active while perceptually processing given features (e.g. deciding if lemon was yellow activated BA 37 and BA 7, while deciding if sugar was sweet activated BA 11/2 etc.). Even more so, Gonzales et al. (2006) found that simple reading of words that denote various scents increased activation in primary olfactory cortex. Similarly, Kiefer, Sim, Herrnberger, Grothe, and Hoenig (2008) observed that areas involved in sound perception were rapidly and selectively activated while recognizing words that denote concepts for which acoustic features are highly relevant (e.g. telephone). At the same time, lesions to these areas affected processing of these specific words (Trumpp, Kliese, Hoenig, Haarmaier & Kiefer, 2013). Numerous studies

presented similar results (e.g. Fernandino, et al. 2015; Kan, Barsalou, Solomon, Minor & Thompson-Schill, 2003; Kurby & Zacks, 2013; Newman, Klatzky, Lederman & Just, 2005; Richter & Zwaan, 2009; Simmons, Martin & Barsalou, 2005; Simmons et al. 2007).

Correspondence of modality specific semantic features to cortical sensory areas that are involved in perceptual processing of those features has been incorporated in theories of embodied cognition, such as Perceptual symbols theory (Barsalou, 1999; 2008; 2010; Barsalou, Simmons, Barbey & Wilson, 2003). These theories originated in Dual coding theory brought by Paivio (1991). Paivio was focused on concreteness advantage in processing and memory-based tasks (Paivio, 1969; 1991; Paivio, Walsh & Bons, 1994; Paivio, Yuille & Madigan, 1968). Concrete words, unlike abstract words, are those that denote objects that can be experienced by senses (e.g. *chair* vs. *truth*). According to Dual coding theory, concrete words are processed faster and more accurately due to their double representation in memory: these words are not only represented in verbal code (via so called logogens, as is the case with abstract words), but in analogue visual code, as well (via so called imagens). This idea could be easily broaden to postulate the existence of analogue codes in modalities other than visual. In other words it could be hypothesized that concrete words are represented in visual, auditory, haptic, olfactory and gustative code.

Traditionally, concreteness has been operationalized through a single measure of either a word concreteness or imageability (Clark & Paivio, 2004; Paivio, Yuille & Madigan, 1968). However, both empirical findings and theoretical advances suggested the importance of separate perceptual modalities in the storing and processing of conceptual knowledge (Barsalou, 1999; 2008; Connell &Lynott, 2010; Fernandino et al. 2015; Golberg, Perfetti & Schneider, 2006; Kiefer, et al. 2008; Lynott & Connel, 2010). Therefore, traditional measures should be replaced with a more detailed measure – namely the one that would capture the fine grained information on the extent to which a word (i.e. an object denoted by that word) can be experienced by separate sensory modalities. Such attempts have been reported. For example, Lynott and Connel (2013) provided norms for 400 nouns. In that research each noun was rated for the extent to which it was possible to see, hear, smell, taste and touch an object denoted by that noun. Similar norms have been published for adjectives (Gainotti, Ciaraffa, Silveri &Marra, 2009; Lynott & Connel, 2009),

as well as for concept-property item pairs (van Dantzig, Cowell, Zeelenberg & Pecher, 2011). In addition to separate per-modality average ratings, the authors provided two integrative measures – modality-exclusivity and strength of perceptual experience. Modality exclusivity is defined as "a measure of the extent to which a particular property is perceived through a single perceptual modality" (Lynott & Connel, 2009: 560). It is calculated as the ratio of range of values (the difference between the highest and the lowest value) and the sum of values obtained in the rating task. This way, words that can be experienced through a single sensory modality would have the highest score (100%), and words that can be experienced equally across sensory modalities would have the lowest score (0%). However, we find that this measure did not capture the differences between words that can be experienced equally strongly through several modalities and words that can be experienced equally weakly through several modalities. This issue has been resolved to some extent by the measure of strength of perceptual experience (Connell & Lynott, 2012). Strength of perceptual experience is operationalized as "the highest rating in the concept's dominant modality and the maximum component of the vector" (Connell & Lynott, 2012: 457), vector being the sequence of ratings for separate modalities. In a step-wise regression to processing latencies observed in visual lexical decision and naming tasks, this measure outperformed both traditional measure of word concreteness and that of imageability. However, we find that some information is lost in this measure, as well. Being restricted to the extent of sensory experience only in the dominant modality, this measure did not capture the information on the extent of sensory experience in other sensory modalities.

1.1. Current goal

In the present paper we tested for the effects of several integrative measures of per-modality concreteness. We applied the same rating procedure as Lynott and Connel (2009) and Connell and Lynott (2012), that is we kept separate information on the extent of sensory experience within individual modalities, and we provided integrative measures. However, some of our integrative measures comprised advantages of both previously suggested measures, and brought some additional information. We therefore

believed that a more suitable name for these measures would be perceptual richness.

We firstly conducted a norming study in order to calculate several measures of perceptual richness and performed several analyses in order to investigate the relations among them. We particularly looked at the relation between each of these measures with that of concreteness, as traditionally defined. Next, we performed a visual lexical decision experiment and compared these measures regarding their potential to account for the variance in processing time. In order to make the findings more comparable to those that have been reported, we followed the rational of Connell and Lynott (2012).

In the following section we described the measures that were tested in this paper.

1.1.1. Modality specific perceptual strength

Modality specific perceptual strength was operationalized as the mean rating on the scale that is linked to a given sensory modality. In other words, it is the mean rating of the possibility of experiencing something by a given sensory modality. For example, visual perceptual strength is the mean rating of the possibility of seeing something, auditory perceptual strength is the possibility of hearing something and so on. These ratings were collected across five modalities (Visual strength, Auditory strength, Olfactory strength, Gustatory strength, Tactile strength).

1.1.2. Integrative measures

We calculated several integrative measures, some of which are identical to those described in Connell and Lynott (2012; Modality exclusivity, Maximum perceptual strength, Summed perceptual strength, Vector length), and some of which are proposed for the first time (Number of modalities, Entropy).

Modality exclusivity is calculated as the ratio of the range of modality specific perceptual strengths across the five modalities and their sum (as firstly described in Lynott & Connell, 2009). This measure is at its maximum for those objects that can be experienced by a single modality, and at its minimum for those that can be experienced by all modalities.

Maximum perceptual strength is operationalized as the maximum modality specific perceptual strength across the five modalities (as described in Connell & Lynott, 2012). Here, the information on the variety of modalities that can be applied to experiencing particular object is lost to the sole information on the intensity of activating the single, most activated modality.

Number of modalities is conceptualized as the number of modalities through which an object denoted by a given word can be experienced (as in Popović Stijačić & Filipović Đurđević, 2015). It was operationalized as the number of modality specific perceptual strengths with values ≥4 (on a seven-point scale). This measure preserves the information on the variety of modalities that can be addressed by an object, but loses the information on the differences among the modalities regarding per-modality perceptual strengths.

Summed perceptual strength was calculated as the sum of modality specific perceptual strengths across the five modalities (Connell & Lynott, 2012). This measure is influenced both by the number of modalities and per-modality perceptual strengths, but loses the fine-grained information on the distribution of per-modality perception strengths across individual modalities.

Vector length was operationalized as Euclidean distance of the vector from the origin, vector being the one that contains five modality specific perceptual strengths (Connell & Lynott, 2012). It represents the magnitude of the five-element vector. Its general caracteristics are similar to summed perceptual strength.

Entropy of perceptual modalities has not been previously described as the integrative measure of perceptual richness. However, it has been applied extensively in psycholinguistic research to describe the richness of inflectional and semantic aspects of words (Baayen, Milin, Filipović Đurđević, Hendrix & Marelli, 2011; Filipović Đurđević, 2007; Filipović Đurđević & Kostić, 2009; in preparation; Milin, Filipović Đurđević & Moscosodel Prado Martín, 2009; Tabak, Schreuder & Baayen, 2005). Here, we propose to apply entropy in order to capture the information on balance of per-modality perceptual strengths. Entropy of modalities would be at its maximum for words with equal values of per-modality perceptual strength, and at its minimum for words with levels of per-modality perceptual strengths that vary across modalities. We operationalized this measure by applying Shan-

non's Entropy (Shannon, 1949) to probability of experiencing an object by a given perceptual modality. This probability is operationalized as the relative frequency of participants whose rating of the individual word on a scale associated with a given modality was ≥4.

1.1.3. Possibility to experience vs. experienced

For each of the described measures we calculated two parallel variants: one that is based on ratings of possibility to experience, and the other one based on the actual experiencing. To our best knowledge, this attempt has not been previously reported. We believe that potential differences in the predictive power of these two variants could reveal whether concreteness effects are bound to modality specific memory traces of the actual sensory experience, or they could be transferred in a top-down manner from the category knowledge, or sensory specific memory traces with other members of the same category.

2. Norming study

We firstly conducted a norming study in order to collect traditional concreteness ratings, as well as separate per-modality ratings and in order to calculate the measures of perceptual richness. We analysed the relations among the collected measures, and we compared new measures regarding their predictiveness of traditional concreteness ratings.

2.1. Method

The norming study consisted of three phases. In the first phase we collected stimuli based on production tasks, in the second phase we collected perceptual experience ratings, and in the third phase concreteness ratings were collected.

2.1.1. Participants

Ninety-four participants took part in the first phase of the norming study (production task), 74 participated in the second phase (perceptual experience ratings), and 51 participated in the third phase (concreteness

rating). They were all native speakers of Serbian and students at the Department of Psychology at the Faculty of Philosophy in Novi Sad and the Faculty of Philosophy in Belgrade.

2.1.2. Materials and procedure

A set of 200 Serbian nouns was collected in the first phase of the norming study, based on results of production tasks. In this task, participants were randomly assigned to one of the four groups, and each group was given different instructions. The instruction to the first group was to think of words that denote objects that can only be seen and to list as many as possible of such words. The second group was instructed to perform the same task for the words that can be experienced only through one sensory modality other than vision; the third group was listing words that can be experienced through as many senses as possible disregarding vision, and the fourth group was listing words that can be experienced through as many senses as possible (vision included). This was done in order to collect a set of concrete nouns that would be as diverse as possible.

In the second phase, the nouns collected were divided into five lists and each list was rated on perceptual experience within a single modality: either visual, auditory, olfactory, gustatory or tactile. Lists were rotated across sensory modalities in accordance with Latin square design. Within each list there were three different random orderings of words. Each participant was presented with one list. On top of each page there was a reminder of the sensory modality that was to be rated on a given page and explanation on the interpretation of the rating scales. Next to each word we printed two seven-point scales. Participants were asked to read each word carefully and provide two ratings: one of the extent to which it would be possible to experience a given object through a given sensory modality and one of the extent to which they had previously experienced the same object through the same sensory modality. For example, the *moon* could be experienced through tactile modality, but most people did not have that experience.

In the third phase all of the stimuli were rated for traditional concreteness (Paivio, Yuille & Madigan, 1968). We used a seven-point scale with an instruction to rate the extent to which it is possible to experience an object denoted by the given word using various senses (one marked abstract words and seven marked highly concrete words).

A list of stimuli and their associated measures are listed in Appendix A, Appendix B, and Appendix C.

2.1.3. Design

Concreteness ratings were treated as a dependent variable and separate per-modality ratings, along with integrative measures of perceptual richness were treated as independent variables.

2.2. Results and discussion

2.2.1. Descriptive analysis

For each word we calculated mean ratings per sensory modality and integrative measures of perceptual richness for both the possibility to experience and for the experiencing given object through the given modality. Descriptive statistics of collected measures are presented in Table 1 and a sample of words with respective measures is presented in Table 2.

Table 1. Descriptive statistics of per-modality perceptual strength and derived integrative measures.

	Mean	-95%CI	+95% CI	SD	SE
Concreteness	5.61	5.50	5.71	0.75	0.05
Possibility of experiencing					
Visual strength	5.14	4.85	5.42	2.05	0.14
Auditory strength	3.08	2.77	3.40	2.27	0.16
Olfactory strength	2.80	2.52	3.08	2.01	0.14
Gustatory strength	2.56	2.29	2.83	1.93	0.14
Tactile strength	3.81	3.57	4.05	1.73	0.12
Modality exclusivity	0.49	0.46	0.52	0.22	0.02
Maximum perceptual strength	6.47	6.38	6.57	0.67	0.05
Number of modalities	2.03	1.87	2.18	1.14	0.08
Summed perceptual strength	17.39	16.70	18.08	4.96	0.35
Vector length	9.00	8.73	9.27	1.93	0.14
Entropy	1.53	1.45	1.61	0.55	0.04
Experienced					
Visual strength	4.65	4.37	4.94	2.04	0.14
Auditory strength	2.83	2.55	3.11	1.98	0.14

Olfactory strength	2.51	2.26	2.76	1.79	0.13
Gustatory strength	1.92	1.68	2.15	1.68	0.12
Tactile strength	3.16	2.94	3.39	1.64	0.12
Modality exclusivity	0.54	0.51	0.57	0.22	0.02
Maximum perceptual strength	5.81	5.66	5.96	1.06	0.07
Number of modalities	1.67	1.52	1.81	1.02	0.07
Summed perceptual strength	15.08	14.42	15.73	4.71	0.33
Vector length	7.89	7.60	8.17	2.05	0.14
Entropy	1.36	1.28	1.44	0.59	0.04

Table 2. Sample of words and their respective ratings/measures.

Word	Concreteness	Visual strength	Auditory strength	Olfactory strength	Gustatory strength	Tactile strength	Modality exclusivity	Maximum perceptual strength	Number of modalities	Summed perceptual strength	Vector length	Entropy
Possibility of experiencing												
DUGA (rainbow)	4.55	6.92	1	1.06	1	1	0.99	6.92	1	10.98	7.21	0.04
GROM (thunder)	5.02	3.23	6.79	1.72	1	3.58	0.51	6.79	1	16.32	8.56	1.76
CVRKUT (chirp)	5.1	1.23	6.57	1.11	1	1	0.94	6.57	1	10.91	6.92	0.04
UBOD (sting)	5.55	3.62	1.29	1.11	1.12	6.83	0.64	6.83	1	13.96	7.99	0.93
ZEMLJOTRES (earthquake)	5.02	2.85	3.14	1.17	1.06	3.33	0.35	3.33	0	11.55	5.62	1.58
VATRA (fire)	5.92	6.31	4.5	3.94	1.47	7	0.3	7	3	23.22	11.26	1.97
PANTALONE (trousers)	6.19	6.28	1.59	2.33	2.23	6.36	0.35	6.36	2	18.79	9.63	1.79
TESTERA (saw)	6	6.41	6.75	1.23	1.79	5.22	0.34	6.75	3	21.4	10.89	1.6

SAPUN (soap)	6.49	6.33	1.23	6.07	4.56	6.59	0.27	6.59	4	24.78	11.94	1.99
PRASE (pig)	6.67	6.92	4.62	5.21	4.94	4.94	0.11	6.92	5	26.63	12.05	2.31
Experienced												
DUGA (rainbow)		5.31	1	1.11	1	1.33	0.91	5.31	1	9.75	5.76	0.47
GROM (thunder)		2.85	6.21	1.39	1	1.25	0.68	6.21	1	12.7	7.16	1.32
CVRKUT (chirp)		1.08	5.93	1.06	1	1	0.97	5.93	1	10.06	6.28	0.04
UBOD (sting)		2.54	1.21	1.06	1.06	5.58	0.7	5.58	1	11.45	6.43	0.62
ZEMLJOTRES (earthquake)		1.38	2.36	1.17	1	1.67	0.53	2.36	0	7.58	3.55	1.37
VATRA (fire)		5.77	3.79	3.72	1.06	4.42	0.34	5.77	2	18.75	9.06	1.96
PANTALONE (trousers)		6.39	1.65	2.42	1.23	6.23	0.4	6.39	2	17.91	9.47	1.35
TESTERA (saw)		5.12	5.08	1.15	1.14	3	0.38	5.12	2	15.5	7.98	1.52
SAPUN (soap)		6.42	1.15	5.93	2.17	6.65	0.32	6.65	3	22.31	11.25	1.77
PRASE (pig)		4.92	3.38	3.86	3.11	3.35	0.13	4.92	1	18.62	8.45	2.24

It can be observed that majority of words from our sample were rated as highly concrete. Across separate modalities perceptual strength was highest for visual modality and lowest for auditory and olfactory modality. Ratings for possibility of experiencing were consistently slightly higher than ratings of actually experiencing the given object through the given modality. This is not surprising, as for example, a *lion* can be touched, but most people have never had the actual experience of touching a lion. However, the two were highly correlated across modalities (Table 3).

Table3. Correlation coefficients between ratings of possibility of experiencing and experienced perceptual strength.

	Correlation coefficient
Visual strength	0.932
Auditory strength	0.977
Olfactory strength	0.966
Gustatory strength	0.897
Tactile strength	0.910
Modality exclusivity	0.941
Maximum perceptual strength	0.665
Number of modalities	0.790
Summed perceptual strength	0.884
Vector length	0.850
Entropy	0.868

N=200; all coefficients are significant at level $p<0.001$

In the next step we looked at pairwise zero-order correlations between modality-specific perceptual strength ratings and concreteness, as well as at correlational structure among modality specific perceptual strength ratings (Table 4). All of the observed correlations were statistically significant and moderate (around 0.5). All of the rated modality-specific perceptual strengths were directly proportional to concreteness ratings, except for auditory perceptual strength, which was inversely proportional to concreteness. Interestingly, this pattern has also been observed in previous research (Connel & Lynott, 2009; 2012; Lynott & Connell, 2013). Correlations among modality-specific ratings were positive for most of the modalities, suggesting that objects that can be experienced through one sensory modality generally can be experienced through another one. The exception was auditory modality, which suggested that objects that can be heard tend to be invisible to other modalities. Finally, these coefficients were also of moderate intensity. The only exception was the high positive pairwise correlation coefficient between gustatory and olfactory ratings, which suggested that objects that can be tasted usually can be smelled, as well.

Overall, these findings demonstrated that modality-specific perceptual experience is related to concreteness. However, two important issues need to be noted. Firstly, not all of the modalities contribute to concreteness in the same direction, and secondly, each of the modalities could account

for only a part of variance of concreteness ratings. These findings are in accordance with those reported in previous research (Connel & Lynott, 2009; 2012; Lynott & Connell, 2013). One difference between our findings and the previous ones was that correlation coefficients were somewhat higher in our dataset, which could point to stimuli-specific differences (we will return to this in the general discussion).

Table 4. Zero-order correlations between per-modality perceptual strength and concreteness.

	Visual	Auditory	Olfactory	Gustatory	Tactile	Concreteness
Possibility of experiencing						
Visual strength	-	-0.647	0.309	0.361	0.451	0.585
Auditory strength		-	-0.382	-0.372	-0.315	-0.236
Olfactory strength			-	0.812	0.371	0.581
Gustatory strength				-	0.344	0.686
Tactile strength					-	0.551
Experienced						
Visual strength	-	-0.554	0.340	0.279	0.464	0.602
Auditory strength		-	-0.348	-0.269	-0.203	-0.204
Olfactory strength			-	0.683	0.428	0.590
Gustatory strength				-	0.257	0.580
Tactile strength					-	0.517

N=200; all coefficients are significant at level $p<0.001$

We also analysed pair-wise zero-order correlations between integrative measures of perceptual richness and concreteness ratings, as well as between pairs of integrative measures (Table 5). All of the derived measures were correlated with concreteness in an expected direction. An increase in concreteness was followed by lower modality exclusivity, higher maximum perceptual strength, larger number of modalities, higher summed perceptual strength, larger vector length and larger entropy. The inspection of inter-relations among integrative measures revealed that there are groups of similar measures. As expected, modality exclusivity and entropy were highly negatively

correlated, and summed perceptual strength and vector length were highly positively correlated. The latter were also positively correlated with number of modalities, whereas the only measure that was either not correlated or was mildly correlated with the other measures was maximum perceptual strength. This measure was also least correlated with concreteness ratings. This was surprising as it was found to be the best candidate in previous research (Connel & Lynott, 2009; 2012; Lynott & Connell, 2013). However, our results so far have favoured integrative measures that tap into multiple modalities and not only the dominant one (as is the case with maximum perceptual strength).

Overall, by comparing pair-wise zero-order correlations of concreteness and various measures (Table 4 and Table 5), it can be observed that correlation coefficients are much higher in case of integrative measures, as compared to those of modality-specific perceptual strengths.

Table 5. Zero-order correlations between integrative measures and concreteness.

	1	2	3	4	5	6	Concreteness
Possibility of experiencing							
Modality exclusivity (1)	-	(-0.029)	-0.775	-0.887	-0.806	-0.958	-0.686
Maximum perceptual strength (2)		-	0.266	0.359	0.498	(0.077)	0.536
Number of modalities (3)			-	0.917	0.908	0.699	0.743
Summed perceptual strength (4)				-	0.983	0.838	0.827
Vector length (5)					-	0.754	0.860
Entropy (6)						-	0.653
Experienced							
Modality exclusivity (1)	-	(-0.111)	-0.700	-0.823	-0.708	-0.943	-0.660
Maximum perceptual strength (2)		-	0.530	0.576	0.724	0.243	0.498
Number of modalities (3)			-	0.917	0.908	0.676	0.691
Summed perceptual strength (4)				-	0.977	0.819	0.784
Vector length (5)					-	0.727	0.778
Entropy (6)						-	0.651

N=200; all coefficients are significant at level $p<0.001$ except the ones that are put in brackets

2.2.2. Predicting concreteness

After describing the general structure of our dataset, we wanted to further test for the predictive power of different measures of perceptual richness. We therefore applied several regression analyses with traditional concreteness as the dependent variable.

In order to control for collinearity all of the predictors were centred to zero and divided by standard deviation (Gelman & Hill, 2007). Collinearity in our dataset was high, as tested using Kappa coefficient (Belsley, Kuh & Welsch, 1980). We analyzed our data using R statistical software (http://www.r-project.org/) and mgcv package (Wood, 2006; 2011). Mixed-effect generalized additive models were fitted to individual ratings using ordered categorical distribution as the appropriate functional form (this was necessary due to the fact that response distribution was not Gaussian, but heavily tailed peaking at maximum level of the seven-point scale). To make sure that coefficients were not influenced by extreme values of predictors, after fitting each model, we excluded points with residuals that exceeded the range of -2.5/+2.5 standard units and refitted each model. This procedure did not bring any substantial changes in the structure of the results, and we therefore reported the coefficients from the refitted models. Model comparisons were performed using itsadug package (van Rij, Wieling, Baayen & van Rijn, 2015) by testing the differences between the values of maximum likelihood (ML) as the measure of goodness of fit (AIC scores were not compared, as our model included component that accounted for autocorrelation in the data, in which case AIC scores are not reliable, as noted by the authors of the package). When comparing ML scores, in addition to looking at statistical significance of Chi-square, we also looked at the ML difference values, as suggested by the authors of the package (difference in scores that is less than five is considered too small).

We fitted separate models for each of the integrative measures to avoid collinearity problems (because of the high correlations between tested measures). In addition to critical integrative measure, each model included a by-participant factor smooth for the effect of order of trial presentation and a by-item random intercept. This way we were able to control for the noise in the data produced by participant-based and item-based differences that were not of the direct interest in our research. The coefficients from the basic model, with the predictors that were common to all of the fitted models is presented in Table 6.

Table 6. Coefficients from the basic generalized additive model fitted to concreteness ratings.

Parametric coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)
Intercept	6.155	0.362	16.990	<0.001
Trial (order of presentation)	0.185	0.111	1.664	0.096

Smooth terms:

	edf	Ref.df	χ^2	p-value
by-Participant factor smooths for Trial	204.4	440	19263	<0.001
by-Item random intercept	190.6	199	4081	<0.001

N=9604; ML=10793

The results revealed that each of the tested integrative measures significantly contributed to predicting concreteness ratings (Table 7). Next, in order to rank integrative measures for their prediction of concreteness, we performed pair-wise comparisons of the models. Firstly, we compared models within the possibility-to-experience-based and the experience-based group (Table 7, column χ^2_1). The best model fit was obtained for the model that included vector length, both for possibility to experience and experience based ratings, and summed perceptual strength was the following best candidate (although its experience-based variant produced equally good fit). In case of the possibility to experience ratings, number of modalities was next in rank, followed by entropy and modality exclusivity, which were equal in terms of model fit. In the case of experience-based ratings this order was slightly different, as modality exclusivity led to better model fit than number of modalities and entropy. Finally, in both variants, the worst model fit was obtained by the model that included maximum perceptual strength. Finally, for each integrative measure, we compared possibility-to-experience-based and experience-based variants (Table 7, column χ^2_2). The results unequivocally revealed that concreteness ratings were better predicted by integrative measures that are based on the possibility to experience than on the experience itself. This is not surprising if we take into account that instruction for concreteness rating included the possibility of experiencing (Paivio, Yuille & Madigan, 1968).

Table 7. Coefficients, their standard errors, corresponding z values and probabilities for integrative measures that are obtained in separate models fitted to concreteness ratings (models differed only with respect to included integrative measure and were the same in all other aspects). The ML column brings measure of fit of the entire model in which the given integrative measure was included. Models are listed in the ascending order based on ML values (best fit on the top); column χ^2_1 brings χ^2 values from the comparisons of successive models in the list; column χ^2_2 brings χ^2 values from the comparisons of experience-based versus the possibility-to-experience-based variants of a single measure; χ^2 values are listed next to the winning model; all χ^2 values were significant at the level of $p<0.0001$, but only $\chi^2>5$ is considered as an index of better fit.

	Coefficient	SE	z value	Pr(>|z|)	ML	χ^2_1	χ^2_2
Possibility to experience							
Vector length	1.375	0.058	23.834	<0.001	10653	**24.671**	**64.311**
Summed perceptual strength	1.330	0.062	21.330	<0.001	10678	**29.992**	**40.211**
Number of modalities	1.210	0.075	16.111	<0.001	10708	**14.415**	**29.802**
Entropy	1.032	0.086	1.977	<0.001	10722	2.089	**26.757**
Modality exclusivity	-1.093	0.082	-13.303	<0.001	10724	**44.464**	**6.463**
Maximum perceptual strength	0.785	0.099	7.954	<0.001	10769	/	**10.502**
Experienced							
Vector length	1.245	0.071	17.490	<0.001	10717	0.571	
Summed perceptual strength	1.277	0.069	18.583	<0.001	10718	**12.748**	
Modality exclusivity	-1.086	0.084	-12.939	<0.001	10731	**6.835**	
Number of modalities	1.121	0.082	13.708	<0.001	10738	**11.37**	
Entropy	1.063	0.086	12.420	<0.001	10749	**30.298**	
Maximum perceptual strength	0.736	0.101	7.310	<0.001	10779	/	

3. Experiment

Our next goal was to investigate whether the measures of perceptual richness would outperform that of concreteness as traditionally defined. In order to do so, we conducted a visual lexical decision experiment and com-

pared the measures in question with respect to their potential to account for the processing time variance.

3.1. Method

3.1.1. Participants

Forty students from the Department of Psychology at the Faculty of Philosophy in Novi Sad participated in the experiment. They were all native speakers of Serbian and had normal or corrected to normal vision.

3.1.2. Materials and design

A full set of 200 nouns collected in the norming study was presented along with 200 of pseudo-nouns. Only words were analysed in the regression analyses. Independent variables were average ratings of perceptual experiences for five sensory modalities, integrative measures and traditional concreteness ratings and dependent variables were reaction time and accuracy. Word length in letters/phonemes and (log) lemma frequency were included as control variables.

3.1.3. Procedure

Participants were engaged in a visual lexical decision task. Stimuli were preceded with a fixation point for 1500 ms. Each stimulus would stay on the screen for maximum of 1500 ms or until the participant's response. Order of stimuli presentation was randomized individually across participants. Prior to the experiment, participants were presented with a trial session. Twenty stimuli presented in the trial session were not analysed and were not repeated later in the experiment.

3.2. Results and discussion

Prior to the analysis we excluded six words that elicited more than 25% of errors. None of the participants were excluded as overall accuracy was very high. Reaction times were reciprocally transformed (-1000/RT) according to Baayen and Milin (2010). Collinearity testing, scaling of the predictors, model criticism and model comparisons were performed in the same way, using the same software and the same packages as in the norm-

ing study. However, here mixed-effect generalized additive models were fitted to reaction latencies using Gaussian distribution as the appropriate functional form.

We first calculated zero-order correlations between our predictors and reaction latencies (Table 8). As was the case with concreteness, they were significantly correlated with processing latencies. The only exception was perceptual strength within auditory domain. An increase in perceptual strength across all remaining domains was followed with a decrease in processing latencies, as was the case with all of the integrative measures (except for modality exclusivity which is expected to be positively correlated with reaction time, as observed).

Table 8. Zero-order correlations between per-modality perceptual strength, integrative measures and reaction time.

	Correlation coefficient	
Word length in letters/phonemes	0.564***	
(log) Lemma frequency	-0.570***	
Concreteness	-0.255***	
	Possibility to experience	*Experienced*
Visual strength	-0.253***	-0.293***
Auditory strength	0.113	0.059
Olfactory strength	-0.220**	-0.216**
Gustatory strength	-0.213**	-0.199**
Tactile strength	-0.193**	-0.227**
Modality exclusivity	0.260***	0.290***
Maximum perceptual strength	-0.185**	-0.269***
Number of modalities	-0.250***	-0.244***
Summed perceptual strength	-0.292***	-0.334***
Vector length	-0.303***	-0.348***
Entropy	-0.256***	-0.293***

*** $p<0.001$; **$p<0.01$; *$p<0.05$

In the next section we investigated whether (a) concreteness and integrative measures of perceptual richness affect processing latencies, (b) integrative measures have the effect even if included in the model simultaneously with concreteness, and (c) integrative measures outperform con-

creteness, that is whether they contribute to processing time over and above concreteness, whereas the same does not hold for concreteness (i.e. concreteness does not contribute to prediction of reaction time over and above an integrative measure). We did so by following the general logic of Connel and Lynott (2012).

3.2.1. Effects of concreteness and perceptual richness on reaction time

In order to test for the effects of concreteness and integrative measures of perceptual richness on processing latencies we built separate models for each of the predictors. We first built a base model to account for the variance that can be linked to control variables and variables that are not of novel interest. We therefore fitted mixed-effects generalized additive model with word length in letters/ phonemes and (log) lemma frequency as parameters. We also included by-participant factor smooth for the effect of order of trial presentation and a by-item random intercept. The coefficients from the basic model are presented in Table 9.

Table 9. Coefficients from the basic generalized additive model fitted to response latencies.

Parametric coefficients:				
	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	-1.497	0.025	-59.546	<0.001
Trial (order of presentation)	-0.003	0.007	-0.429	0.668
Word length (in characters/phonemes)	0.074	0.009	8.229	<0.001
Log-Lemma frequency	-0.063	0.009	-7.045	<0.001
Smooth terms:				
	edf	Ref.df	F	p-value
by-Participant factor smooths for Trial	138.6	359	9.427	<0.001
by-Item random intercept	167.9	190	7.482	<0.001

N=7277; ML=220.08

We then built separate models by adding only one of the critical predictors and performed model comparisons between the basic model (random effects, word length, lemma frequency) and each of the models with measures of concreteness/perceptual richness (basic model + additional

measure). The change in ML score for each of the comparisons, along with statistical significance of the observed change is plotted in Figure 1.

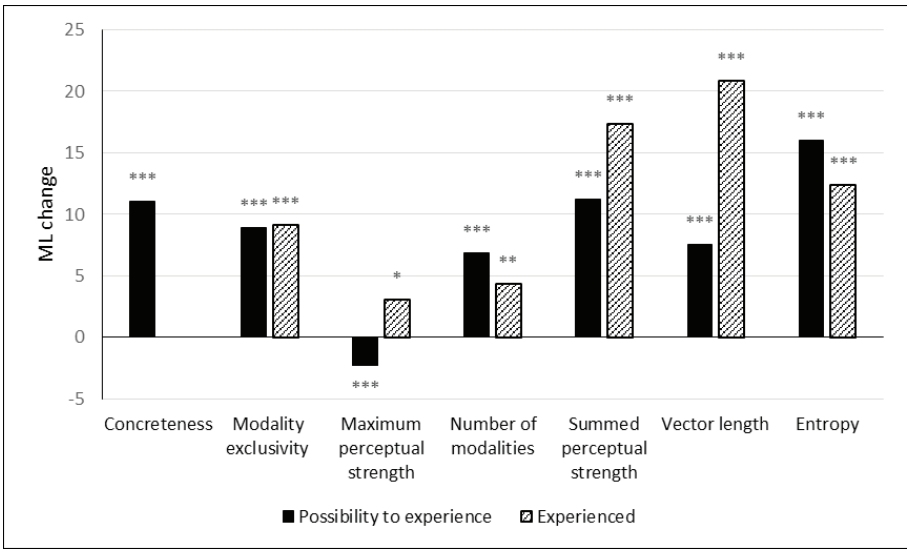

Figure 1. Contribution of concreteness (rated without the possibility to experience/experience division) and integrative measures over and above the effect of word length and lemma frequency (as well as the effect of by-participant trial order and by-item random effect). Larger ML change indicates better fit of the model with the critical predictor over the base model.*** p<0.001; **p<0.01; *p<0.05

We observed that only one of the integrative measures of perceptual richness – maximum perceptual strength – did not contribute to predicting reaction time over and above the effect of control variables. In the case of rated possibility to experience, adding of this measure to the model even led to slight increase of ML values.

In case of rated experience, inclusion of this measure did improve the fit, albeit the change in ML score was below 5 units. Additionally, the number of modalities derived from rated experience was just below the 5-unit threshold. Concreteness and all of the remaining integrative measures did improve the model fit. For these measures we performed pair-wise comparisons of the two variants (possibility to experience and experienced), and

observed that for most of them the two variants led to an equally good model fit. However, the experienced-based variant was more successful in the case of vector length (χ^2=13.289, df_{diff}=0, p<0.001) and summed perceptual strength (χ^2=6.162, df_{diff}=0, p<0.001).

3.2.2. Effects of perceptual richness over and above the effect of concreteness

In the next step, we wanted to test for the effects of integrative measures when they were included in the model simultaneously with concreteness. We therefore included concreteness in the broadened basic model (random effects, word length, lemma frequency and concreteness). Again, we fitted separate models for each of the integrative measures and compared indicators of goodness of fit for these models (ML and AIC). Each model included the broadened basic model and one of the integrative measures. This was necessary as high correlations between different integrative measures would lead to collinearity problems in case of their simultaneous inclusion in a single model. The effects of the control variables were in an expected direction and significant (Table 10). Model coefficients for each of the critical predictors (integrative measures) are summarized in Table 11.

Table 10. Coefficients from the broadened basic generalized additive model fitted to response latencies.

Parametric coefficients:				
	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	-1.497	0.025	-59.832	<0.001
Trial (order of presentation)	-0.003	0.007	-0.486	0.627
Word length (in characters/phonemes)	0.071	0.009	8.275	<0.001
Log-Lemma frequency	-0.068	0.009	-7.923	<0.001
Concreteness	-0.038	0.008	-4.917	<0.001
Smooth terms:				
	edf	Ref.df	F	p-value
by-Participant factor smooths for Trial	139.0	359	9.432	<0.001
by-Item random intercept	164.2	189	6.595	<0.001

N=7277; ML=208.99

As summarized in Table 11, almost all of the integrative measures significantly contributed to predicting reaction time along with the control variables. Most importantly, their contribution was significant along with that of word concreteness. The only measure that did not have a significant effect was maximum perceptual strength. Interestingly, this measure was the best candidate in the research of Connell and Lynnott (2012) and we will return to this issue in the general discussion. Another measure suggested by the same authors – modality exclusivity (Connel & Lynott, 2009; Lynott & Connell, 2013) was a significant predictor of reaction time over and above concreteness in our dataset. However, the effect of this variable was comparable to the effects of other integrative measures – number of modalities, summed perceptual strength, vector length and entropy. In the case of both rated possibility to experience and rated experience, we observed that number of modalities, summed perceptual strength and vector length (and entropy in case of rated experience) cancelled out the effect of concreteness, demonstrating that there was no new information in concreteness when compared to integrative measures based on modality-specific perceptual experience. Even though pairwise model comparisons often suggested significant advantage of one model over the other, the observed differences in ML and AIC were very small and thus did not allow for reliable conclusions as to which of the tested integrative measures would be the best candidate.

Based on these findings we can conclude that measures that directly capture modality specific perceptual information are more closely linked to processing efforts than traditional concreteness is (in accordance with and as suggested by Connell & Lynnott, 2012). Additionally, the best predictors of processing latencies seem to be those that capture perceptual strength across all of the tested modalities, not only within the dominant modality (contrary to previous findings). Finally, although the differences were minimal, we observed a slight tendency for measures based on actual experience rating to be better at accounting for processing latencies than those based on rating of the possibility of experiencing.

Table 11. Coefficients, their standard errors, corresponding t values and probabilities for integrative measures that are obtained in separate models fitted to reaction time (models differed only with respect to integrative measure and were the same in all other aspects). The final two columns bring measures of fit of the entire model in which the given integrative measure was included.

	Coefficient	SE	t value	Pr(>|t|)	ML	
Possibility to experience						
Modality exclusivity	0.026	0.009	2.799	0.005	207.95	**
Maximum perceptual strength	0.013	0.009	1.376	0.169	207.85	
Number of modalities	-0.025	0.010	-2.543	0.011	212.11	*
Summed perceptual strength	-0.036	0.013	-2.635	0.008	205.53	**
Vector length	-0.035	0.015	-2.344	0.019	209.25	*
Entropy	-0.027	0.010	-2.694	0.007	205.28	**
Experienced						
Modality exclusivity	0.022	0.008	2.644	0.008	211.68	**
Maximum perceptual strength	-0.013	0.009	-1.502	0.133	207.81	
Number of modalities	-0.031	0.010	-2.975	0.003	207.97	**
Summed perceptual strength	-0.057	0.012	-4.784	<0.001	208.48	***
Vector length	-0.055	0.012	-4.725	<0.001	199.13	***
Entropy	-0.034	0.010	-3.378	0.001	206.43	***

Finally, in order to test for the independent effects of integrative measures over and above that of concreteness, we performed two series of model comparisons. In the first series, each of the models from Table 9 was compared with a broadened basic model, that is with the same model that did not contain an integrative measure. In other words, concreteness was present in both models, but integrative measure was present in only one of the two models. We then performed model comparisons and looked into indicators of change in model fit. The upper panel in Figure 2 illustrates the change in ML score. A larger value indicated more improvement to the model fit, which is achieved by the inclusion of an additional parameter (integrative measure), whereas negative values indicated that adding the parameter spoiled goodness of fit. In the second series of model comparisons, we paired models that both contained an integrative measure, but only one

of them contained concreteness. We again looked at the change in goodness of fit measures and plotted the change in ML score in the lower panel of Figure 2.

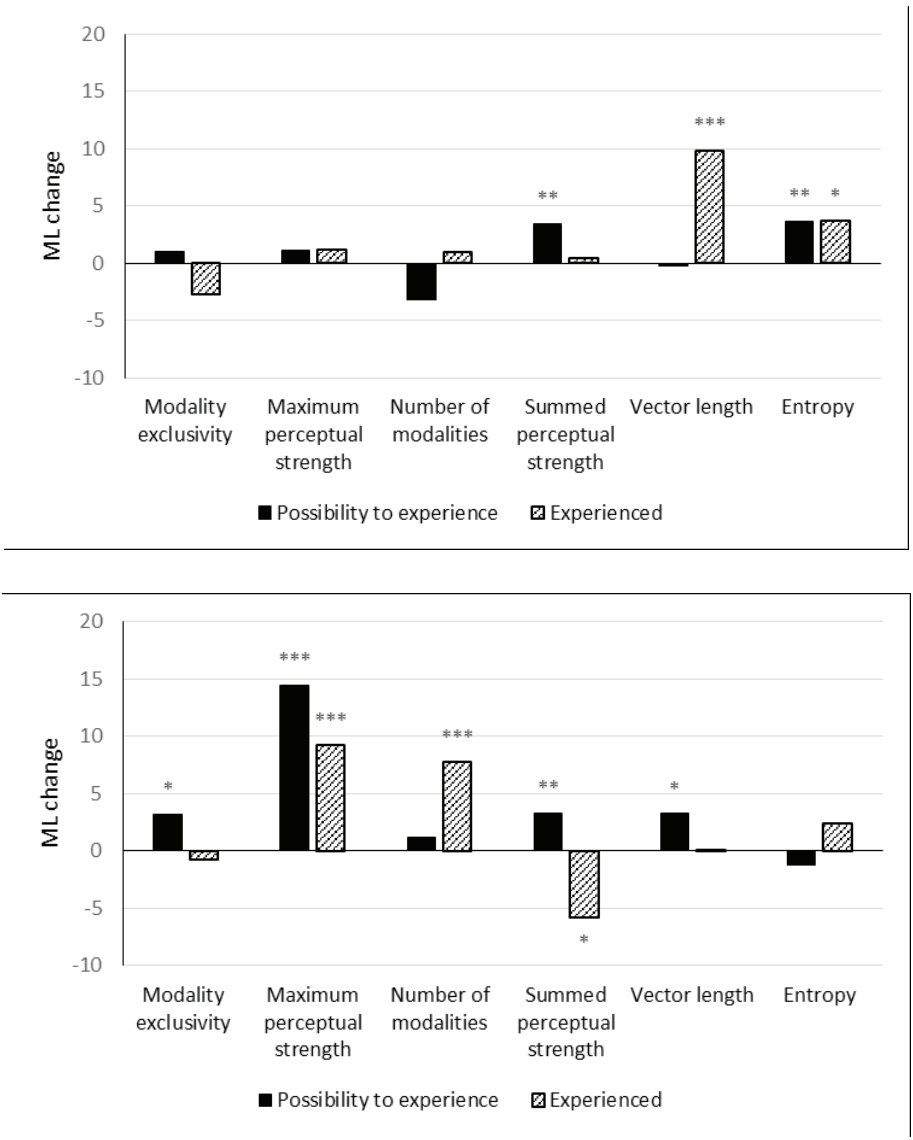

Figure 2. Upper panel: Contribution of integrative measures over and above the effect of the model that included concreteness (along with

word length and lemma frequency, as well as the effect of by-participant trial order and by-item random effect). Lower panel: Contribution of concreteness over and above the effect of the model that included separate integrative measures (along with word length and lemma frequency, as well as the effect of by-participant trial order and by-item random effect). *** $p<0.001$; **$p<0.01$; *$p<0.05$

As can be seen in Figure 2 (upper panel), the only integrative measure that satisfied the criterion of ML change being both significant and above 5 units, that is the only integrative measure that contributed over and above the effect of concreteness was vector length. At the same time, this measure was not outperformed by concreteness (Figure 2, lower panel). This indicated that vector length captured information that is both unrelated to traditional concreteness and relevant for processing efforts. None of the remaining measures outperformed concreteness, and most of them were not outperformed by concreteness. The only measure that was outperformed was maximum perceptual strength. However, this was not surprising, as the simple effect of this measure was not significant (Figure 1; Table 10).

The finding that maximum perceptual strength does not predict processing latencies and that measures that include multiple modalities are better predictors contradicts findings reported by Connel and Lynott (2012). However, regarding wider issues of general significance of direct perceptual experience, our results go in line with theirs (as will be discussed further).

4. General discussion

This research has brought three major insights. Firstly, it corroborated earlier findings (Connel & Lynott, 2009; 2012; Lynott & Connell, 2013) that although modality-specific perceptual experience and concreteness are related, there are some major differences. Secondly, it corroborated earlier findings that modality exclusivity and maximum perceptual strength predict both concreteness and processing time. However, our research brought additional evidence on the relevance of several other integrative measures for both concreteness ratings and processing latencies. This indicated that the relation between modality-specific experience and processing could be

more complex than initially suggested. Thirdly, our research introduced a novel division of the modality specific sensory ratings into those that refer to the possibility of experiencing something and those that refer to the actual experience.

This research has revealed that noun concreteness ratings are influenced by several aspects of multisensory experience with an object denoted by the given noun. On the one hand, we have shown that perceptual strength of each modality contributed significantly to concreteness ratings, but accounted only for part of the concreteness variance. On the other hand, we have tested for the effects of several integrative measures on concreteness ratings and have shown that all of them had significant influence. Additionally, we have demonstrated that these integrative measures did not necessarily operate in alternation, but that some of them contributed to prediction of concreteness ratings over and above the other measures. This was the case with the number of modalities through which an object could be experienced, summed perceptual strength and entropy of modalities. In a lexical decision task, we demonstrated that most of the integrative measures overpowered concreteness ratings in predicting reaction time.

We also observed that pairwise correlation between concreteness and each of the tested measures was higher for integrative measures than for modality-specific perceptual strengths. This could indicate that concreteness rating, as traditionally defined, seems to be a product of some internal integration of information originating from different senses. Based on this finding we could introduce a practical recommendation regarding the use of concreteness measure: if the goal is theoretical understanding, then modality-specific information should be taken into account; however, is the goal is general matching of stimuli, then traditionally operationalized concreteness could suffice.

Regarding the division of modality-specific sensory ratings into those that relate to the possibility of experiencing and those that relate to the actual experience, we obtained at least two important insights. Firstly, we observed that the parallel variants systematically go in line, as we observed high correlation coefficients between the pairs of measures. Secondly, we observed that there are some differences between the two, which could encourage further examination. For example, measures based on possibility to experience were better predictors of concreteness ratings, whereas

measures based on the actual experience were better predictors of processing time. This could suggest that concreteness rating was a task that taped into conscious processes and was thus more influenced by our knowledge, whereas lexical decision task was more influenced by neural traces of actual perceptual experience. We plan to continue to investigate these differences.

Recent research (Connel & Lynott, 2009; 2012; Lynott & Connell, 2013) has drawn attention to the significance of understanding the contribution of separate sensory modalities to cognitive processing. This contribution has been addressed via examining the extent of perceiving an object denoted by a given word through each of the sensory modalities, so called perceptual strength. It has been shown that word concreteness, as traditionally defined, is only partly influenced by perceptual strength across modalities and that word processing latencies are better predicted by maximum perceptual strength, that is perceptual strength of the dominant modality (the highest rating in the five element vector).

Regarding wider theoretical implications, our findings go in line with those of Connel and Lynott (2009; 2012), as we have demonstrated that sensory specific memory traces are significant for word processing. However, regarding more fine grained findings, our results diverge from those of Connel and Lynott. For example, we observed somewhat larger correlation coefficients among per-modality sensory ratings. Even more interestingly, the measure that proved to be the best candidate in their research was among the least successful candidates in accounting for either concreteness or processing time variance in our case. The same applied to the winning candidate(s) from our analyses: summed perceptual strength and vector length were tested and discarded as unsuccessful in Connel and Lynott (2012). We do not believe that this discrepancy puts our two investigations at opposing ends. We also do not believe that it is a concequence of language differences, as the origin of the observed variation is unrelated to that in word forms, but to deeper conceptual organization. We believe that it suggests the importance of the selected stimuli set. For example, our stimuli consisted only of nouns, whereas Connel and Lynott (2012) included nouns and adjectives. Also, we tentatively collected words that denote objects that can be experienced in a certain way (e.g. participants were listing words that can be experienced by as large a possible number of sensory modalities as possible). Thus, we believe that the observed discrepancy points to the need of collecting large

datasets of norms and performing analysis on a much bigger sample than is the one presented in either of the two papers.

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Appendix A: Lemma frequency, Familiarity, Word length in letters, Concreteness and Reaction Time in the Visual Lexical Decision experiment.

Word	Lemma frequency (per 2 mil)	Familiarity	Word length in graphemes	Concreteness	RT (ms)
BLJESAK	133	6.38	6		
BOJA	830	7.00	4		
DIM	478	6.77	3		
DUGA	180	6.92	4		
HORIZONT	99	6.92	8		
IMEJL	0	6.62	5		
INTERNET	0	6.77	8		
ISKRA	136	6.31	5		
KOMETA	11	6.31	6		
MAGLA	631	6.69	5		
MESEČINA	424	6.92	8		
MIMIKA	5	6.77	6		
POMRAČINA	1	6.62	9		
MUNJA	216	6.69	4		
NEBO	2818	7.00	4		
OBLAK	1565	7.00	5		
ODSJAJ	67	6.77	6		
OSMEH	720	7.00	5		
SENKA	1209	6.77	5		

SLOVO	248	6.92	5
SVETLOST	667	6.77	8
TEKST	87	7.00	5
VARNICA	72	6.38	7
VATROMET	22	6.69	8
ZVEZDA	1856	6.85	6
PLAKAT	27	6.62	6
VENA	83	6.69	4
GRMLJAVINA	40	6.69	9
GROM	115	6.77	4
PUCKETANJE	3	6.69	9
ŽUBOR	76	6.08	5
ARLAUKANJE	1	5.00	6
BUKA	60	6.77	4
CVRKUT	86	6.77	6
GALAMA	16	6.69	6
GLAS	1513	7.00	4
GRČ	169	6.38	3
KRČANJE	1	6.38	6
LAVEŽ	37	6.69	5
MELODIJA	78	6.85	8
MUZIKA	446	7.00	6
ODJEK	164	6.46	5
PLIN	22	6.46	4
PUCANJ	95	6.62	5
SPARINA	9	6.38	7
ŠAPAT	302	6.92	5
ŠKRIPA	45	6.46	6
TON	64	6.85	3
UBOD	26	6.69	4
VAZDUH	332	7.00	6
VETAR	2274	6.92	5
VIBRACIJA	1	6.77	9
ZADAH	26	6.69	5

ZEMLJOTRES	18	6.69	9
ZUJANJE	5	6.77	6
ZVEKET	32	6.00	6
ZVIŽDUK	36	6.46	7
ZVONJAVA	27	6.69	7
ZVUK	656	7.00	4
ALARM	4	6.85	5
CVILJENJE	0	6.54	7
EHO	27	6.15	3
GRAVITACIJA	7	6.77	11
INERCIJA	3	6.15	8
JAUK	125	6.38	4
KRCKANJE	4	6.15	7
KRIK	422	6.23	4
MJAUK	0	6.54	5
PROMAJA	11	6.77	7
STRUJA	163	7.00	6
VRISAK	140	6.62	6
KIČMA	40	6.85	5
PLUĆA	99	6.85	5
ACETON	1	6.92	6
VETRENJAČA	14	6.15	9
PUTOKAZ	58	6.46	7
TROTOAR	59	6.92	7
ANTENA	16	6.62	6
BANDERA	7	6.69	7
BILBORD	0	6.69	7
BRK	45	6.77	3
CRTEŽ	70	6.92	5
ČAŠA	423	7.00	4
ČIGRA	26	6.00	5
DALEKOVOD	2	6.08	9
ĐERDAN	47	3.54	6
EKRAN	8	7.00	5

FOTOGRAFIJA	71	6.92	11
IGLA	97	6.77	4
KAMEN	872	6.85	5
KIŠOBRAN	29	6.92	8
KNJIGA	649	7.00	5
KOMPJUTER	0	7.00	8
KREVET	235	6.92	6
KROV	648	6.85	4
KUTLAČA	0	6.46	7
LAVA	35	6.23	4
LEPTIR	197	6.77	6
MINĐUŠA	10	7.00	7
MONITOR	2	7.00	7
ODŽAK	10	6.15	4
PATIKA	0	7.00	6
PČELA	105	6.77	5
PERTLA	1	7.00	6
PLANETA	47	7.00	7
PLANINA	584	6.85	7
PODOČNJAK	7	6.85	9
PROZOR	1096	6.92	6
RADIJATOR	1	6.77	9
REFLEKTOR	17	6.46	9
SATELIT	10	6.23	7
SIJALICA	58	7.00	8
SLIKA	737	6.77	5
SUNCE	2984	7.00	5
SVESKA	50	7.00	6
ŠAL	22	6.92	3
ŠIŠKE	2	7.00	5
TREPAVICA	86	6.92	9
VATRA	719	6.85	5
APLAUZ	24	6.85	6
DAH	643	6.77	3

DETONACIJA	2	5.77	10
OTKUCAJ	26	6.62	7
PESMA	2626	7.00	5
POLEN	2	6.69	5
PRIČANJE	15	7.00	7
PULS	12	6.85	4
KUCANJE	2	6.77	6
SMEH	736	6.92	4
ŠKRGUT	38	5.23	9
CIGLA	58	6.31	5
FLAŠA	43	6.92	5
NOKAT	111	6.92	5
NOVČANICA	14	6.92	9
NOŽ	356	6.92	3
OLOVKA	19	7.00	6
PANTALONE	22	7.00	9
PAPIR	75	7.00	5
SUKNJA	53	7.00	5
TORBA	71	6.92	5
USTA	416	7.00	4
TASTATURA	0	6.92	9
ŽBUN	38	6.77	4
PLJESAK	21	6.38	6
KAŠALJ	12	6.77	5
AUTOBUS	45	7.00	7
CIGARETA	71	6.92	8
CVRČAK	47	6.31	6
ČARAPA	36	6.92	6
ČASOVNIK	47	6.92	8
DETERDŽENT	0	6.85	9
DEZODORANS	0	7.00	10
IZMET	2	6.62	5
KREM	9	7.00	5
LEPAK	4	6.69	5

MAJICA	4	6.85	6
NAFTA	46	6.46	5
PEPELJARA	2	6.92	8
PTICA	1671	6.92	5
REKA	1465	7.00	4
SMOLA	64	6.54	5
SVEĆA	188	6.85	5
ŠEĆER	77	6.92	5
ŠLAG	0	6.62	4
TELEVIZOR	0	7.00	9
TESTERA	13	6.08	7
TORTA	8	6.92	5
VODA	2210	7.00	4
VOSAK	38	6.62	5
ŽABA	25	6.62	4
PRAŠINA	185	6.62	7
AUTOMOBIL	131	7.00	9
BAJADERA	4	6.46	8
BANANA	12	7.00	6
BOMBONA	7	7.00	7
BOSILJAK	14	6.08	7
BRESKVA	34	7.00	7
BUREK	4	6.92	5
CIMET	1	6.46	5
CIPELA	103	7.00	6
CVET	930	7.00	4
ČAJ	52	6.85	3
ČOKOLADA	16	7.00	8
GROŽĐE	121	6.92	6
HLEB	592	7.00	4
JOGURT	1	7.00	6
KAFA	55	7.00	4
KARMIN	3	6.92	6
KIŠA	1285	7.00	4

KRUŠKA	53	7.00	6
NARANDŽA	60	6.92	7
PAPRIKAŠ	3	6.85	8
PARADAJZ	21	7.00	8
PIVO	27	6.92	4
SAPUN	62	6.92	5
SENO	132	6.31	4
ŠNICLA	8	7.00	6
VISKI	6	7.00	5
SLON	19	6.54	4
PRASE	9	6.77	5

Appendix B: Per-modality ratings of possibility of experiencing and actual experiencing by a given modality.

	Possibility to experience					**Actual experience**				
Word	**Visual**	**Auditory**	**Olfactory**	**Gustatory**	**Tactile**	**Visual**	**Auditory**	**Olfactory**	**Gustatory**	**Tactile**
BLJESAK	6.59	1.58	1.08	1.00	1.59	5.41	1.83	1.00	1.00	1.47
BOJA	6.78	1.00	3.42	2.08	1.07	6.78	1.35	3.42	1.31	1.07
DIM	5.79	1.39	6.94	2.08	1.69	5.36	1.28	5.35	1.83	1.46
DUGA	6.92	1.00	1.06	1.00	1.00	5.31	1.00	1.11	1.00	1.33
HORIZONT	6.50	1.00	1.07	1.06	1.06	5.83	1.00	1.00	1.06	1.00
IMEJL	5.88	1.92	1.08	1.00	1.00	5.65	1.50	1.08	1.00	1.22
INTERNET	4.06	1.71	1.00	1.00	1.00	4.28	1.65	1.00	1.00	1.00
ISKRA	5.79	2.39	1.24	1.33	2.69	4.64	1.94	1.29	1.00	2.08
KOMETA	5.38	1.86	1.17	1.00	1.67	1.62	1.29	1.00	1.00	1.08
MAGLA	5.83	1.08	2.69	2.11	1.65	5.92	1.08	2.14	1.33	1.41
MESEČINA	6.59	1.00	1.15	1.21	1.28	5.94	1.00	1.23	1.14	1.50
MIMIKA	6.72	1.06	1.17	1.23	3.29	6.06	1.06	1.33	1.00	2.36
POMRAČINA	6.14	1.06	1.06	1.00	1.08	6.07	1.28	1.00	1.00	1.00
MUNJA	6.62	2.71	1.11	1.06	1.50	5.23	2.21	1.22	1.00	1.08

NEBO	6.75	1.15	1.00	1.17	1.47	6.75	1.23	1.00	1.28	1.18
OBLAK	6.65	1.50	1.23	1.21	1.67	6.59	1.75	1.08	1.07	1.22
ODSJAJ	6.22	1.06	1.17	1.08	1.71	5.78	1.12	1.17	1.00	1.14
OSMEH	6.36	3.33	1.06	1.08	2.15	6.29	3.39	1.12	1.08	1.85
SENKA	6.62	1.00	1.11	1.00	1.17	6.42	1.00	1.11	1.00	1.33
SLOVO	6.67	1.46	1.07	1.06	2.00	7.00	1.15	1.00	1.06	1.41
SVETLOST	6.59	1.08	1.15	1.36	3.17	6.59	1.33	1.15	1.21	3.17
TEKST	6.89	1.59	1.33	1.00	1.79	6.72	1.71	1.25	1.00	1.64
VARNICA	6.43	3.17	1.82	1.50	3.46	5.43	2.67	1.71	1.17	2.00
VATROMET	6.54	5.71	2.72	1.24	2.42	5.23	5.00	2.22	1.00	1.42
ZVEZDA	6.67	1.00	1.00	1.44	1.71	6.00	1.00	1.00	1.00	1.00
PLAKAT	6.88	1.33	1.92	2.21	4.89	6.71	1.27	1.85	1.57	4.17
VENA	5.72	1.29	1.33	1.62	4.43	5.22	1.12	1.08	1.15	3.21
GRMLJAVINA	2.14	6.61	1.35	1.00	1.85	2.00	6.17	1.29	1.00	1.46
GROM	3.23	6.79	1.72	1.00	3.58	2.85	6.21	1.39	1.00	1.25
PUCKETANJE	1.50	6.31	1.00	1.44	2.06	1.25	5.69	1.00	1.28	1.65
ŽUBOR	1.53	6.25	1.31	1.07	2.11	1.53	5.33	1.31	1.07	1.78
ARLAUKANJE	1.61	6.47	1.08	1.00	1.57	1.17	4.53	1.00	1.00	1.50
BUKA	1.36	7.00	1.35	1.00	1.92	1.21	6.33	1.29	1.00	1.69
CVRKUT	1.23	6.57	1.11	1.00	1.00	1.08	5.93	1.06	1.00	1.00
GALAMA	1.67	7.00	1.14	1.06	1.41	1.92	6.85	1.00	1.00	1.12
GLAS	1.59	7.00	1.23	1.14	2.39	1.76	6.67	1.23	1.14	2.44
GRČ	2.00	1.12	1.00	1.00	5.86	1.67	1.12	1.00	1.00	4.86
KRČANJE	1.21	6.50	1.00	1.00	1.46	1.14	5.67	1.00	1.50	1.23
LAVEŽ	1.62	6.86	1.06	1.00	1.08	1.23	6.21	1.06	1.00	1.25
MELODIJA	1.25	7.00	1.57	1.06	1.71	1.17	6.92	1.29	1.11	1.53
MUZIKA	1.47	7.00	1.23	1.86	1.94	1.53	6.58	1.23	1.71	1.94
ODJEK	1.11	6.94	1.00	1.00	1.93	1.17	5.65	1.00	1.00	1.71
PLIN	2.71	3.11	6.59	3.33	3.00	2.21	2.67	4.53	1.42	1.62
PUCANJ	2.62	6.57	2.94	1.06	3.08	1.46	5.71	1.22	1.12	1.42
SPARINA	1.58	1.00	3.21	1.78	4.88	1.58	1.00	2.86	1.56	4.47
ŠAPAT	1.76	5.08	1.31	1.29	2.28	2.06	4.75	1.38	1.21	2.11
ŠKRIPA	1.22	7.00	1.00	1.00	1.57	1.06	5.71	1.00	1.00	1.57
TON	1.36	6.83	1.00	1.00	1.46	1.21	6.83	1.00	1.00	1.23

UBOD	3.62	1.29	1.11	1.12	6.83	2.54	1.21	1.06	1.06	5.58
VAZDUH	2.58	1.75	5.43	2.11	3.76	2.58	1.83	5.69	1.72	3.76
VETAR	2.18	5.75	3.38	1.64	6.33	2.00	5.58	3.31	1.57	6.44
VIBRACIJA	2.67	4.29	1.17	1.31	6.00	2.33	3.88	1.08	1.00	4.93
ZADAH	1.14	1.61	6.71	2.67	1.92	1.14	1.83	5.12	2.17	1.69
ZEMLJOTRES	2.85	3.14	1.17	1.06	3.33	1.38	2.36	1.17	1.00	1.67
ZUJANJE	1.33	6.69	1.07	1.06	1.59	1.50	6.08	1.00	1.00	1.29
ZVEKET	1.82	6.42	1.00	1.00	1.56	1.76	5.92	1.38	1.00	1.39
ZVIŽDUK	1.83	6.94	1.00	1.00	1.50	1.72	6.24	1.00	1.00	1.21
ZVONJAVA	1.00	6.94	1.38	1.00	1.46	1.00	6.33	1.38	1.00	1.31
ZVUK	1.38	7.00	1.06	1.00	2.08	1.38	7.00	1.28	1.00	2.17
ALARM	1.50	7.00	1.00	1.11	1.35	1.67	5.69	1.00	1.06	1.24
CVILJENJE	2.41	6.83	1.00	1.07	1.67	2.00	5.64	1.00	1.08	1.39
EHO	1.11	6.76	1.00	1.00	1.36	1.11	5.53	1.00	1.00	1.29
GRAVITACIJA	1.64	1.67	1.00	1.08	3.46	1.57	1.94	1.00	1.00	2.62
INERCIJA	1.69	1.14	1.22	1.00	2.67	1.85	1.14	1.22	1.00	2.83
JAUK	2.08	6.92	1.00	1.11	1.12	1.75	5.46	1.00	1.06	1.00
KRCKANJE	2.06	6.00	1.08	1.71	2.00	1.59	5.18	1.08	1.86	1.72
KRIK	1.56	7.00	1.00	1.15	1.64	1.50	4.65	1.00	1.00	1.50
MJAUK	1.50	6.61	1.06	1.00	1.00	1.36	6.22	1.00	1.00	1.00
PROMAJA	1.23	4.36	1.56	1.18	4.58	1.31	3.57	1.50	1.00	4.33
STRUJA	2.17	2.15	1.86	2.94	5.41	1.42	1.77	1.64	1.17	2.41
VRISAK	3.00	7.00	1.23	1.36	1.72	2.29	6.17	1.15	1.21	1.44
KIČMA	5.33	1.18	1.25	1.38	5.07	4.22	1.12	1.08	1.08	3.93
PLUĆA	4.00	3.67	1.00	1.25	2.23	1.79	3.00	1.00	1.08	2.00
ACETON	5.08	1.00	6.89	4.76	3.08	5.08	1.00	5.94	1.41	2.83
VETRENJAČA	6.83	3.46	1.71	1.78	3.29	3.25	1.08	1.08	1.00	1.41
PUTOKAZ	6.76	1.67	1.08	1.14	3.67	6.24	1.50	1.00	1.00	1.89
TROTOAR	6.17	1.47	2.67	2.00	4.29	6.22	1.41	1.67	1.08	2.93
ANTENA	6.64	1.56	1.18	1.83	4.38	6.36	1.33	1.06	1.00	2.62
BANDERA	6.08	1.21	1.11	1.35	3.92	6.08	1.14	1.22	1.06	2.17
BILBORD	6.92	1.00	1.50	1.67	2.94	6.58	1.00	1.29	1.00	1.12
BRK	6.41	1.25	1.54	2.79	6.06	5.35	1.25	1.15	1.93	3.88
CRTEŽ	6.72	1.18	2.42	1.15	3.07	6.61	1.47	2.33	1.31	2.71

ČAŠA	6.57	1.89	1.71	2.08	5.31	6.43	2.00	1.59	2.50	5.31
ČIGRA	6.54	1.57	1.39	1.29	3.25	4.23	1.29	1.06	1.00	1.67
DALEKOVOD	6.08	1.69	1.36	1.56	3.71	4.83	1.15	1.14	1.06	1.41
ĐERDAN	5.76	2.42	1.46	1.64	5.18	3.88	2.75	1.46	1.14	3.65
EKRAN	6.72	1.59	1.25	1.31	4.36	6.50	1.53	1.17	1.08	3.57
FOTOGRAFIJA	6.93	1.50	2.29	1.75	3.23	6.85	1.94	2.29	1.08	3.31
IGLA	6.15	1.14	1.17	1.35	6.58	5.69	1.14	1.28	1.12	3.83
KAMEN	6.67	1.54	2.29	2.83	6.41	6.42	1.54	1.79	1.39	5.53
KIŠOBRAN	6.88	2.42	1.85	2.07	5.00	6.47	2.18	1.92	1.21	4.89
KNJIGA	7.00	2.12	3.67	1.92	5.86	6.78	2.35	4.00	1.38	5.57
KOMPJUTER	6.71	4.22	2.06	1.67	5.08	6.57	4.61	2.12	1.00	5.00
KREVET	6.31	2.14	3.50	1.18	5.08	6.31	2.29	3.56	1.00	5.58
KROV	6.58	1.08	1.43	1.72	4.00	6.42	1.08	1.00	1.06	2.24
KUTLAČA	6.82	1.83	1.46	3.64	5.56	6.12	1.58	1.38	2.71	5.00
LAVA	6.17	2.94	3.83	2.62	4.86	2.00	1.24	1.17	1.00	1.86
LEPTIR	6.57	2.28	1.24	2.67	4.46	6.14	1.89	1.06	1.00	2.92
MINĐUŠA	6.08	1.14	1.44	1.53	5.67	6.08	1.14	1.56	1.29	4.58
MONITOR	6.92	1.85	1.64	1.94	4.94	6.67	2.00	1.36	1.11	4.35
ODŽAK	6.53	1.17	3.54	1.43	3.83	5.35	1.25	3.08	1.14	2.00
PATIKA	6.61	1.88	5.00	2.38	6.21	6.61	1.94	4.83	1.15	5.50
PČELA	6.64	5.83	1.12	2.25	5.54	6.29	5.06	1.06	1.00	3.38
PERTLA	6.00	1.07	1.39	1.29	3.75	5.92	1.07	1.17	1.06	3.83
PLANETA	5.00	1.54	1.36	1.39	2.18	3.25	1.15	1.00	1.06	1.59
PLANINA	6.76	1.83	2.46	1.57	2.56	6.24	2.33	2.08	1.29	2.39
PODOČNJAK	6.56	1.06	1.17	1.31	3.14	6.17	1.06	1.00	1.00	2.50
PROZOR	6.71	2.33	1.47	1.92	4.54	6.50	2.56	1.65	1.17	4.62
RADIJATOR	6.08	1.36	2.72	1.35	5.58	6.00	1.71	2.50	1.06	5.17
REFLEKTOR	6.83	1.23	1.43	1.44	4.47	5.67	1.15	1.21	1.11	2.59
SATELIT	5.53	1.50	1.15	1.00	2.33	1.82	1.17	1.00	1.00	1.06
SIJALICA	6.50	1.65	1.58	1.62	5.21	6.50	1.71	1.83	1.00	4.21
SLIKA	6.93	1.11	2.18	1.92	3.69	6.86	1.22	2.12	1.00	3.54
SUNCE	6.08	1.00	1.39	1.00	5.50	5.85	1.00	1.50	1.00	5.25
SVESKA	6.75	2.00	2.64	2.22	5.94	6.83	2.54	2.29	1.29	5.65
ŠAL	6.47	1.42	2.92	2.50	6.44	5.82	1.92	3.15	1.79	6.00

ŠIŠKE	6.61	1.18	1.67	1.77	5.86	6.50	1.00	1.58	1.69	5.00
TREPAVICA	6.71	1.50	1.00	2.00	4.00	6.57	1.28	1.00	1.50	3.46
VATRA	6.31	4.50	3.94	1.47	7.00	5.77	3.79	3.72	1.06	4.42
APLAUZ	4.08	7.00	1.00	1.11	3.59	3.83	6.31	1.00	1.18	3.59
DAH	2.00	4.83	6.08	2.71	5.56	2.12	4.50	5.69	2.21	5.56
DETONACIJA	3.28	6.88	1.58	1.15	3.93	1.56	4.53	1.08	1.00	2.71
OTKUCAJ	1.21	6.17	1.00	1.00	2.92	1.00	5.33	1.00	1.00	2.38
PESMA	1.92	7.00	1.17	1.06	1.58	2.23	6.86	1.11	1.00	1.83
POLEN	2.83	1.00	5.43	3.50	2.18	2.55	1.00	4.36	2.44	1.59
PRIČANJE	4.59	6.92	1.77	1.43	2.33	4.29	6.42	1.62	1.43	2.33
PULS	2.61	4.06	1.17	1.15	5.93	2.28	3.35	1.08	1.08	5.36
KUCANJE	1.57	6.83	1.00	1.00	3.23	1.36	6.67	1.00	1.00	2.77
SMEH	6.31	6.79	1.44	1.00	2.25	6.69	6.57	1.50	1.00	2.58
ŠKRGUT	1.50	6.38	1.00	1.56	1.41	1.50	5.15	1.00	1.39	1.53
CIGLA	6.65	2.50	2.08	2.08	5.67	5.41	2.08	1.69	1.21	3.94
FLAŠA	6.67	2.19	2.58	2.31	5.64	6.61	2.06	2.25	1.62	5.07
NOKAT	6.50	2.17	2.06	4.00	4.54	6.36	2.11	2.06	2.58	4.62
NOVČANICA	6.15	2.29	4.78	2.41	4.33	5.92	2.07	4.72	1.18	4.42
NOŽ	6.83	1.77	2.50	2.78	6.29	6.67	1.85	2.31	1.61	5.47
OLOVKA	6.71	3.33	2.15	3.57	6.28	6.71	3.73	2.31	2.92	6.33
PANTALONE	6.28	1.59	2.33	2.23	6.36	6.39	1.65	2.42	1.23	6.23
PAPIR	6.64	3.28	3.47	3.75	5.92	6.50	3.72	3.59	2.08	5.77
SUKNJA	5.92	1.50	2.44	1.18	4.33	5.77	1.43	1.89	1.00	3.25
TORBA	6.75	1.31	3.00	2.06	5.94	6.50	1.31	2.50	1.22	5.82
USTA	6.24	2.00	2.54	4.29	6.28	6.06	2.33	2.62	3.93	6.11
TASTATURA	6.67	4.29	1.67	1.69	5.57	6.33	4.41	1.33	1.38	5.14
ŽBUN	6.71	2.17	3.59	3.25	5.00	6.50	2.17	3.00	1.42	4.23
PLJESAK	4.85	6.57	1.11	1.12	6.25	4.38	6.21	1.00	1.06	5.92
KAŠALJ	2.67	6.85	1.43	2.94	2.53	2.25	6.31	1.23	2.61	2.18
AUTOBUS	6.82	6.42	4.00	1.64	4.33	6.76	6.25	4.23	1.50	4.11
CIGARETA	6.78	1.94	6.83	6.08	5.50	6.33	2.00	6.58	3.54	3.71
CVRČAK	5.36	6.39	1.41	3.08	3.08	3.86	4.89	1.29	1.00	2.00
ČARAPA	6.54	1.14	5.11	1.41	5.00	6.31	1.14	3.83	1.06	5.08
ČASOVNIK	6.50	6.62	1.29	2.06	4.88	6.33	6.23	1.23	1.06	4.47

DETERDŽENT	5.59	1.25	6.54	5.29	6.06	5.35	1.17	6.46	2.21	5.61
DEZODORANS	4.89	3.29	6.92	3.31	5.36	4.39	3.59	6.92	1.69	4.64
IZMET	6.64	1.28	6.59	5.58	4.00	5.57	1.33	4.59	1.00	1.92
KREM	6.00	1.14	5.94	4.06	5.83	5.92	1.14	6.06	2.18	5.58
LEPAK	6.00	1.23	6.50	3.89	5.94	5.33	1.08	5.07	1.11	4.18
MAJICA	6.65	1.17	4.08	2.36	6.72	6.94	1.25	4.15	1.86	6.44
NAFTA	5.44	1.18	6.67	4.85	4.14	2.22	1.06	3.75	1.15	2.36
PEPELJARA	6.71	1.44	5.65	3.00	5.15	6.43	1.44	5.12	1.25	4.08
PTICA	6.00	5.14	3.89	3.53	3.67	6.08	4.50	2.11	1.94	2.55
REKA	6.83	4.92	3.79	3.39	6.06	6.50	4.46	3.14	2.33	5.47
SMOLA	5.47	1.33	5.46	4.14	5.67	4.53	1.67	4.85	2.07	4.06
SVEĆA	6.56	2.41	5.25	2.85	5.71	5.56	2.59	4.83	1.69	4.57
ŠEĆER	5.79	1.33	3.88	6.92	3.77	5.50	1.44	3.94	6.75	3.38
ŠLAG	5.92	1.07	5.67	6.88	3.42	5.46	1.07	5.06	6.47	2.92
TELEVIZOR	7.00	5.54	1.86	1.83	5.12	6.75	5.62	1.50	1.11	4.82
TESTERA	6.41	6.75	1.23	1.79	5.22	5.12	5.08	1.15	1.14	3.00
TORTA	6.44	1.06	5.67	7.00	4.57	6.06	1.06	5.67	7.00	3.64
VODA	6.57	5.00	2.76	5.83	6.23	6.43	5.11	2.76	5.92	6.15
VOSAK	5.67	1.21	5.12	4.06	6.00	5.33	1.14	4.65	1.76	4.92
ŽABA	6.67	5.92	4.00	5.00	5.65	5.33	4.23	2.29	1.06	3.18
PRAŠINA	4.88	1.25	4.23	4.36	4.06	4.59	1.08	3.85	2.79	4.39
AUTOMOBIL	6.83	6.24	3.08	1.62	4.71	6.83	6.53	2.83	1.08	4.07
BAJADERA	6.29	1.11	5.41	7.00	3.77	5.50	1.00	5.12	6.00	3.15
BANANA	6.31	1.07	6.00	6.94	2.92	6.08	1.07	6.00	6.71	3.00
BOMBONA	6.58	1.62	5.29	6.94	5.24	6.33	1.54	4.71	6.28	4.82
BOSILJAK	6.06	1.67	6.92	5.86	5.11	4.65	1.50	5.85	4.07	4.00
BRESKVA	6.56	1.00	6.00	7.00	5.43	6.39	1.00	5.67	6.92	5.21
BUREK	6.29	1.11	6.24	7.00	4.00	5.43	1.06	5.18	5.67	3.54
CIMET	6.08	1.00	6.83	6.76	1.75	5.54	1.00	5.89	5.76	1.55
CIPELA	6.83	2.77	4.57	2.22	5.82	6.92	2.62	3.43	1.11	5.76
CVET	6.71	1.25	6.85	4.38	5.72	6.18	1.50	6.69	2.25	5.22
ČAJ	6.11	1.35	6.17	7.00	3.86	5.72	1.65	6.00	6.85	3.14
ČOKOLADA	6.36	1.33	6.00	7.00	4.08	6.00	1.61	5.94	6.83	3.77
GROŽĐE	6.23	1.00	5.39	6.94	3.33	6.00	1.00	4.94	6.41	2.92

HLEB	6.67	1.08	5.79	6.67	5.71	6.67	1.15	5.43	6.56	5.53
JOGURT	6.06	1.33	5.31	7.00	4.72	6.13	1.42	5.15	6.93	4.00
KAFA	6.50	1.71	6.75	7.00	4.50	6.28	1.76	6.50	6.23	3.57
KARMIN	6.00	1.44	5.06	5.33	4.00	5.79	1.50	4.59	3.45	2.62
KIŠA	6.31	5.79	4.67	3.88	6.42	5.92	5.36	4.72	2.47	6.00
KRUŠKA	6.64	1.23	5.57	6.94	6.06	6.00	1.31	4.93	6.24	5.59
NARANDŽA	6.41	1.83	6.46	7.00	5.89	6.41	1.92	6.62	6.86	5.78
PAPRIKAŠ	6.28	1.29	6.50	7.00	3.14	5.17	1.71	5.58	5.92	2.36
PARADAJZ	6.79	1.06	5.94	6.83	4.85	6.64	1.33	5.76	6.00	4.69
PIVO	6.31	1.64	6.06	7.00	2.33	5.69	1.43	4.67	4.94	1.50
SAPUN	6.33	1.23	6.07	4.56	6.59	6.42	1.15	5.93	2.17	6.65
SENO	6.06	3.17	5.92	4.36	5.17	5.18	2.00	4.92	1.64	3.78
ŠNICLA	6.67	1.24	6.58	7.00	4.00	6.39	1.29	6.08	6.92	3.14
VISKI	5.86	1.22	5.76	6.83	3.08	5.07	1.00	3.76	3.00	2.15
SLON	7.00	4.43	4.11	2.41	3.58	3.08	2.71	1.72	1.00	1.08
PRASE	6.92	4.62	5.21	4.94	4.94	4.92	3.38	3.86	3.11	3.35

Appendix C: Integrative measures of perceptual richness

	Possibility to experience						**Actual experience**					
Word	**Modality exclusivity**	**Maximum perceptual strength**	**Number of modalities**	**Summed perceptual strength**	**Vector length**	**Entropy**	**Modality exclusivity**	**Maximum perceptual strength**	**Number of modalities**	**Summed perceptual strength**	**Vector length**	**Entropy**
BLJESAK	0.82	6.59	1	11.84	7.11	0.82	0.77	5.41	1	10.72	6.07	1.05
BOJA	0.62	6.78	1	14.34	8.00	1.38	0.64	6.78	1	13.93	7.89	1.39
DIM	0.43	6.94	2	17.89	9.53	1.71	0.40	5.36	2	15.28	8.03	1.71
DUGA	0.99	6.92	1	10.98	7.21	0.04	0.91	5.31	1	9.75	5.76	0.47
HORIZONT	0.97	6.50	1	10.69	6.83	0.04	0.99	5.83	1	9.89	6.18	0.04

IMEJL	0.83	5.88	1	10.88	6.44	0.64	0.85	5.65	1	10.45	6.15	0.36
INTERNET	0.81	4.06	1	8.76	4.73	0.73	0.84	4.28	1	8.92	4.90	0.83
ISKRA	0.54	5.79	1	13.44	7.05	1.72	0.61	4.64	1	10.96	5.69	1.45
KOMETA	0.72	5.38	1	11.08	6.13	0.89	0.63	1.62	0	5.98	2.73	0.04
MAGLA	0.57	5.83	1	13.36	7.04	1.60	0.70	5.92	1	11.88	6.67	1.09
MESEČINA	0.90	6.59	1	11.23	6.99	0.33	0.85	5.94	1	10.81	6.43	0.34
MIMIKA	0.67	6.72	1	13.46	7.74	1.15	0.74	6.06	1	11.80	6.79	0.81
POMRAČINA	0.96	6.14	1	10.33	6.49	0.04	0.95	6.07	1	10.35	6.44	0.36
MUNJA	0.69	6.62	1	13.00	7.47	1.11	0.74	5.23	1	10.75	5.99	1.00
NEBO	0.88	6.75	1	11.54	7.17	0.34	0.89	6.75	1	11.44	7.15	0.66
OBLAK	0.75	6.65	1	12.26	7.22	0.82	0.82	6.59	1	11.71	7.09	0.85
ODSJAJ	0.83	6.22	1	11.24	6.73	0.41	0.92	5.78	1	10.20	6.19	0.04
OSMEH	0.59	6.36	1	13.99	7.65	1.41	0.60	6.29	1	13.72	7.54	1.32
SENKA	0.95	6.62	1	10.89	6.95	0.04	0.92	6.42	1	10.86	6.80	0.04
SLOVO	0.77	6.67	1	12.26	7.27	0.93	0.91	7.00	1	11.62	7.38	0.34
SVETLOST	0.66	6.59	1	13.35	7.60	1.14	0.64	6.59	1	13.46	7.62	1.09
TEKST	0.78	6.89	1	12.60	7.48	1.23	0.78	6.72	1	12.32	7.30	1.23
VARNICA	0.43	6.43	1	16.38	8.30	1.63	0.53	5.43	1	12.97	6.70	1.60
VATROMET	0.39	6.54	2	18.63	9.50	1.89	0.43	5.23	2	14.87	7.77	1.59
ZVEZDA	0.83	6.67	1	11.82	7.17	0.80	1.00	6.00	1	10.00	6.32	0.04
PLAKAT	0.45	6.88	2	17.24	9.04	1.60	0.51	6.71	2	15.56	8.36	1.39
VENA	0.47	5.72	2	14.39	7.64	1.45	0.61	5.22	1	11.79	6.43	0.89
GRMLJAVINA	0.71	6.61	1	12.95	7.38	1.32	0.75	6.17	1	11.92	6.84	1.25
GROM	0.51	6.79	1	16.32	8.56	1.76	0.68	6.21	1	12.70	7.16	1.32
PUCKETANJE	0.73	6.31	1	12.31	7.03	1.23	0.80	5.69	1	10.87	6.27	0.63
ŽUBOR	0.71	6.25	1	12.27	6.98	1.20	0.71	5.33	1	11.02	6.07	0.94
ARLAUKANJE	0.81	6.47	1	11.74	7.01	0.82	0.84	4.53	1	9.20	5.11	0.53
BUKA	0.79	7.00	1	12.63	7.57	1.10	0.82	6.33	1	11.53	6.86	0.72
CVRKUT	0.94	6.57	1	10.91	6.92	0.04	0.97	5.93	1	10.06	6.28	0.04
GALAMA	0.82	7.00	1	12.28	7.50	0.69	0.85	6.85	1	11.88	7.33	0.62
GLAS	0.70	7.00	1	13.35	7.75	1.20	0.67	6.67	1	13.25	7.51	1.29
GRČ	0.81	5.86	1	10.97	6.45	0.76	0.83	4.86	1	9.64	5.44	0.80
KRČANJE	0.89	6.50	1	11.18	6.92	0.42	0.84	5.67	1	10.54	6.18	0.44
LAVEŽ	0.89	6.86	1	11.61	7.27	0.60	0.91	6.21	1	10.75	6.62	0.44

MELODIJA	0.78	7.00	1	12.58	7.55	0.65	0.83	6.92	1	12.02	7.38	0.34
MUZIKA	0.68	7.00	1	13.50	7.74	1.21	0.67	6.58	1	13.00	7.34	1.34
ODJEK	0.85	6.94	1	11.98	7.43	0.57	0.84	5.65	1	10.53	6.18	0.61
PLIN	0.28	6.59	1	18.75	8.98	2.20	0.42	4.53	1	12.44	6.09	1.88
PUCANJ	0.49	6.57	1	16.27	8.33	1.84	0.77	5.71	1	10.93	6.29	0.44
SPARINA	0.52	4.88	1	12.46	6.39	1.67	0.54	4.47	1	11.47	5.84	1.60
ŠAPAT	0.57	5.08	1	11.72	6.12	1.14	0.54	4.75	1	11.52	5.89	1.19
ŠKRIPA	0.88	7.00	1	11.79	7.41	0.57	0.88	5.71	1	10.33	6.18	0.61
TON	0.88	6.83	1	11.65	7.26	0.71	0.93	6.83	1	11.28	7.19	0.04
UBOD	0.64	6.83	1	13.96	7.99	0.93	0.70	5.58	1	11.45	6.43	0.62
VAZDUH	0.35	5.43	1	15.64	7.60	1.90	0.37	5.69	1	15.60	7.72	1.90
VETAR	0.33	6.33	2	19.29	9.60	1.96	0.35	6.44	2	18.91	9.49	1.95
VIBRACIJA	0.46	6.00	2	15.44	8.04	1.66	0.48	4.93	1	13.23	6.85	1.47
ZADAH	0.61	6.71	1	14.05	7.73	1.44	0.57	5.12	1	11.95	6.20	1.47
ZEMLJOTRES	0.35	3.33	0	11.55	5.62	1.58	0.53	2.36	0	7.58	3.55	1.37
ZUJANJE	0.84	6.69	1	11.74	7.17	0.52	0.86	6.08	1	10.87	6.55	0.42
ZVEKET	0.80	6.42	1	11.80	6.99	0.99	0.76	5.92	1	11.45	6.55	1.09
ZVIŽDUK	0.82	6.94	1	12.27	7.47	0.79	0.85	6.24	1	11.17	6.73	0.64
ZVONJAVA	0.88	6.94	1	11.78	7.37	0.67	0.89	6.33	1	11.02	6.76	0.37
ZVUK	0.80	7.00	1	12.52	7.57	0.91	0.77	7.00	1	12.83	7.63	1.22
ALARM	0.86	7.00	1	11.96	7.44	0.69	0.83	5.69	1	10.65	6.23	0.65
CVILJENJE	0.73	6.83	1	12.98	7.58	1.08	0.76	5.64	1	11.10	6.31	0.91
EHO	0.92	6.76	1	11.23	7.13	0.38	0.92	5.53	1	9.93	5.95	0.41
GRAVITACIJA	0.64	3.46	0	8.85	4.43	1.16	0.52	2.62	0	8.13	3.88	1.39
INERCIJA	0.61	2.67	0	7.72	3.71	0.99	0.60	2.83	0	8.04	3.90	1.31
JAUK	0.82	6.92	1	12.24	7.47	0.62	0.85	5.46	1	10.27	6.00	0.67
KRCKANJE	0.63	6.00	1	12.85	6.95	1.49	0.64	5.18	1	11.43	6.08	1.19
KRIK	0.82	7.00	1	12.35	7.51	0.64	0.78	4.65	1	9.65	5.30	0.79
MJAUK	0.91	6.61	1	11.17	7.01	0.38	0.94	6.22	1	10.58	6.60	0.40
PROMAJA	0.43	4.58	2	12.90	6.73	1.38	0.50	4.33	1	11.71	6.04	1.58
STRUJA	0.37	5.41	1	14.53	7.12	2.08	0.37	2.41	0	8.41	3.87	1.37
VRISAK	0.62	7.00	1	14.31	8.02	1.35	0.69	6.17	1	12.27	6.94	0.87
KIČMA	0.45	5.33	2	14.22	7.68	1.26	0.49	4.22	1	11.43	6.07	1.03
PLUĆA	0.42	4.00	1	12.15	6.08	1.52	0.52	3.00	0	8.87	4.29	1.42

ACETON	0.37	6.89	3	20.81	10.32	1.95	0.44	5.94	2	16.27	8.49	1.51
VETRENJAČA	0.42	6.83	1	17.08	8.70	1.94	0.80	3.25	0	7.82	3.98	0.64
PUTOKAZ	0.61	6.76	1	14.32	8.03	1.30	0.79	6.24	1	11.62	6.83	0.70
TROTOAR	0.41	6.17	2	16.59	8.35	1.90	0.62	6.22	1	13.31	7.30	1.37
ANTENA	0.52	6.64	2	15.59	8.40	1.58	0.73	6.36	1	12.36	7.15	0.73
BANDERA	0.57	6.08	1	13.67	7.54	1.49	0.75	6.08	1	11.67	6.75	0.93
BILBORD	0.66	6.92	1	14.02	7.91	1.24	0.93	6.58	1	10.99	6.95	0.38
BRK	0.40	6.41	2	18.04	9.46	1.65	0.49	5.35	1	13.57	7.10	1.46
CRTEŽ	0.58	6.72	1	14.54	7.95	1.40	0.56	6.61	1	14.44	7.77	1.67
ČAŠA	0.39	6.57	2	17.56	9.06	1.77	0.38	6.43	2	17.82	9.07	1.89
ČIGRA	0.58	6.54	1	14.04	7.71	1.19	0.76	4.23	1	9.24	4.94	0.52
DALEKOVOD	0.50	6.08	1	14.39	7.61	1.47	0.82	4.83	1	9.60	5.39	0.64
ĐERDAN	0.38	5.76	2	16.46	8.41	1.63	0.35	3.88	0	12.88	6.28	1.81
EKRAN	0.54	6.72	2	15.23	8.36	1.17	0.61	6.50	1	13.84	7.74	1.15
FOTOGRAFIJA	0.51	6.93	1	15.70	8.31	1.70	0.55	6.85	1	15.48	8.25	1.75
IGLA	0.48	6.58	2	16.40	9.26	1.18	0.57	5.69	1	13.06	7.16	1.19
KAMEN	0.35	6.67	2	19.74	10.06	2.00	0.43	6.42	2	16.66	8.90	1.63
KIŠOBRAN	0.38	6.88	2	18.22	9.27	1.87	0.45	6.47	2	16.68	8.70	1.59
KNJIGA	0.33	7.00	2	20.56	10.24	2.00	0.36	6.78	3	20.09	10.02	1.93
KOMPJUTER	0.34	6.71	3	19.74	9.78	1.97	0.39	6.57	3	19.30	9.74	1.83
KREVET	0.39	6.31	2	18.21	9.16	1.77	0.39	6.31	2	18.73	9.48	1.78
KROV	0.56	6.58	2	14.81	8.09	1.43	0.80	6.42	1	11.78	7.03	0.52
KUTLAČA	0.37	6.82	2	19.32	9.81	1.55	0.40	6.12	2	16.80	8.61	1.46
LAVA	0.23	6.17	2	20.41	9.58	2.20	0.44	2.00	0	7.26	3.37	1.02
LEPTIR	0.44	6.57	2	17.21	8.77	1.75	0.64	6.14	1	13.01	7.21	1.27
MINĐUŠA	0.45	6.08	2	15.86	8.65	1.47	0.51	6.08	2	14.65	7.96	1.30
MONITOR	0.43	6.92	2	17.29	9.06	1.78	0.53	6.67	2	15.49	8.39	1.57
ODŽAK	0.47	6.53	1	16.50	8.56	1.49	0.54	5.35	1	12.82	6.71	1.29
PATIKA	0.28	6.61	3	22.09	10.80	2.06	0.36	6.61	3	20.04	10.12	1.79
PČELA	0.34	6.64	3	21.38	10.73	1.82	0.45	6.29	2	16.78	8.87	1.51
PERTLA	0.58	6.00	1	13.50	7.40	0.98	0.60	5.92	1	13.05	7.31	1.00
PLANETA	0.56	5.00	1	11.46	5.99	1.66	0.74	3.25	0	8.05	4.07	0.64
PLANINA	0.51	6.76	1	15.19	8.01	1.75	0.53	6.24	1	14.32	7.48	1.64
PODOČNJAK	0.67	6.56	1	13.23	7.55	0.92	0.77	6.17	1	11.73	6.88	0.81

PROZOR	0.44	6.71	2	16.97	8.77	1.89	0.46	6.50	2	16.48	8.61	1.70
RADIJATOR	0.39	6.08	2	17.09	8.90	1.63	0.43	6.00	2	16.44	8.54	1.72
REFLEKTOR	0.54	6.83	2	15.41	8.50	1.35	0.68	5.67	1	11.73	6.55	0.76
SATELIT	0.70	5.53	1	11.52	6.37	1.09	0.79	1.82	0	6.05	2.79	0.04
SIJALICA	0.43	6.50	2	16.56	8.79	1.48	0.54	6.50	2	15.25	8.20	1.67
SLIKA	0.54	6.93	1	15.83	8.44	1.73	0.60	6.86	1	14.74	8.16	1.48
SUNCE	0.51	6.08	2	14.97	8.43	1.19	0.51	5.85	2	14.60	8.12	1.29
SVESKA	0.33	6.75	2	19.56	9.84	1.98	0.41	6.83	2	18.60	9.59	1.88
ŠAL	0.34	6.47	2	19.75	10.01	1.84	0.31	6.00	2	18.68	9.31	1.88
ŠIŠKE	0.45	6.61	2	17.08	9.24	1.53	0.51	6.50	2	15.78	8.58	1.43
TREPAVICA	0.56	6.71	2	15.21	8.27	1.57	0.63	6.57	1	13.81	7.75	1.35
VATRA	0.30	7.00	3	23.22	11.26	1.97	0.34	5.77	2	18.75	9.06	1.96
APLAUZ	0.51	7.00	2	16.78	8.99	1.49	0.49	6.31	1	15.91	8.35	1.63
DAH	0.25	6.08	3	21.18	10.13	2.07	0.24	5.69	3	20.08	9.64	2.03
DETONACIJA	0.48	6.88	1	16.83	8.80	1.67	0.60	4.53	1	10.88	5.70	1.11
OTKUCAJ	0.71	6.17	1	12.30	7.07	1.14	0.76	5.33	1	10.72	6.09	0.89
PESMA	0.77	7.00	1	12.73	7.60	1.12	0.73	6.86	1	13.03	7.59	1.06
POLEN	0.45	5.43	1	14.94	7.45	1.70	0.48	4.36	1	11.94	5.91	1.60
PRIČANJE	0.46	6.92	2	17.04	8.92	1.82	0.45	6.42	2	16.09	8.35	1.77
PULS	0.48	5.93	2	14.92	7.82	1.48	0.53	5.36	1	13.15	6.89	1.45
KUCANJE	0.68	6.83	1	13.64	7.85	1.12	0.73	6.67	1	12.79	7.48	1.12
SMEH	0.45	6.79	2	17.79	9.69	1.55	0.43	6.69	2	18.35	9.89	1.66
ŠKRGUT	0.79	6.38	1	11.85	6.96	1.05	0.75	5.15	1	10.57	5.84	0.90
CIGLA	0.33	6.65	2	18.97	9.55	1.72	0.45	5.41	1	14.35	7.32	1.56
FLAŠA	0.31	6.67	2	19.39	9.65	1.98	0.40	6.61	2	17.61	9.02	1.92
NOKAT	0.31	6.50	3	19.26	9.37	2.04	0.34	6.36	2	17.73	8.78	2.00
NOVČANICA	0.26	6.15	3	19.96	9.51	2.13	0.36	5.92	3	18.31	9.09	1.88
NOŽ	0.33	6.83	2	20.17	10.17	1.91	0.39	6.67	2	17.90	9.26	1.86
OLOVKA	0.27	6.71	2	22.04	10.62	2.02	0.26	6.71	2	22.00	10.62	2.00
PANTALONE	0.35	6.36	2	18.79	9.63	1.79	0.40	6.39	2	17.91	9.47	1.35
PAPIR	0.19	6.64	2	23.06	10.77	2.25	0.27	6.50	2	21.66	10.32	2.10
SUKNJA	0.46	5.92	2	15.38	7.97	1.62	0.57	5.77	1	13.34	7.10	1.46
TORBA	0.39	6.75	2	19.05	9.79	1.90	0.43	6.50	2	17.35	9.25	1.74
USTA	0.26	6.28	3	21.34	10.35	2.01	0.24	6.11	2	21.05	10.09	2.08

TASTATURA	0.34	6.67	3	19.89	9.98	1.74	0.37	6.33	3	18.61	9.47	1.74
ŽBUN	0.29	6.71	2	20.72	9.91	2.17	0.41	6.50	2	17.31	8.71	1.98
PLJESAK	0.37	6.57	3	19.90	10.40	1.59	0.38	6.21	3	18.57	9.75	1.59
KAŠALJ	0.47	6.85	1	16.42	8.43	1.75	0.53	6.31	1	14.58	7.61	1.54
AUTOBUS	0.28	6.82	4	23.22	11.19	2.11	0.29	6.76	4	22.86	11.04	2.06
CIGARETA	0.22	6.83	4	27.13	12.79	2.09	0.27	6.58	2	22.17	10.67	2.09
CVRČAK	0.35	6.39	2	19.32	9.51	2.01	0.48	4.89	1	13.04	6.74	1.56
ČARAPA	0.38	6.54	3	19.20	9.86	1.70	0.42	6.31	2	17.43	9.10	1.54
ČASOVNIK	0.33	6.62	3	21.34	10.76	1.96	0.37	6.33	3	19.32	10.08	1.59
DETERDŽENT	0.27	6.54	4	24.72	11.84	2.01	0.33	6.46	3	20.81	10.40	1.86
DEZODORANS	0.19	6.92	3	23.76	11.06	2.21	0.32	6.92	3	21.23	10.22	1.94
IZMET	0.28	6.64	4	24.09	11.68	2.04	0.49	5.57	2	14.42	7.65	1.56
KREM	0.27	6.00	4	22.98	11.10	1.98	0.31	6.06	3	20.88	10.44	1.84
LEPAK	0.28	6.50	3	23.56	11.41	1.98	0.36	5.33	3	16.77	8.60	1.60
MAJICA	0.35	6.72	3	20.97	10.63	1.84	0.36	6.94	3	20.65	10.58	1.79
NAFTA	0.32	6.67	4	22.28	10.78	1.98	0.49	3.75	0	10.54	5.20	1.41
PEPELJARA	0.31	6.71	3	21.96	10.71	2.01	0.39	6.43	3	18.32	9.37	1.85
PTICA	0.14	6.00	2	22.23	10.17	2.27	0.34	6.08	2	17.17	8.48	2.00
REKA	0.17	6.83	3	24.99	11.55	2.24	0.25	6.50	3	21.91	10.36	2.14
SMOLA	0.25	5.67	4	22.07	10.53	2.09	0.26	4.85	3	17.17	8.22	2.03
SVEĆA	0.23	6.56	3	22.78	10.82	2.11	0.27	5.56	3	19.24	9.20	2.04
ŠEĆER	0.33	6.92	2	21.69	10.60	1.96	0.33	6.75	2	21.02	10.24	2.03
ŠLAG	0.32	6.88	3	22.96	11.29	1.95	0.34	6.47	3	20.98	10.34	1.92
TELEVIZOR	0.32	7.00	3	21.35	10.61	1.89	0.38	6.75	3	19.80	10.19	1.71
TESTERA	0.34	6.75	3	21.40	10.89	1.60	0.38	5.12	2	15.50	7.98	1.52
TORTA	0.30	7.00	4	24.74	12.03	1.99	0.32	7.00	3	23.42	11.50	1.93
VODA	0.18	6.57	4	26.40	12.19	2.27	0.17	6.43	4	26.37	12.16	2.24
VOSAK	0.28	6.00	4	22.06	10.59	2.00	0.33	5.33	3	17.80	8.87	1.80
ŽABA	0.12	6.67	5	27.24	12.35	2.32	0.39	5.33	2	16.08	7.92	1.79
PRAŠINA	0.26	4.88	4	18.78	8.87	1.99	0.30	4.59	2	16.69	8.00	1.89
AUTOMOBIL	0.30	6.83	3	22.48	10.95	1.86	0.35	6.83	3	21.34	10.73	1.85
BAJADERA	0.32	7.00	3	23.58	11.54	1.98	0.32	6.00	3	20.77	10.17	1.97
BANANA	0.32	6.94	3	23.24	11.56	1.91	0.32	6.71	3	22.85	11.32	1.95
BOMBONA	0.26	6.94	4	25.66	12.23	2.11	0.26	6.33	4	23.69	11.29	2.10

BOSILJAK	0.25	6.92	4	25.62	12.16	2.11	0.29	5.85	4	20.06	9.52	2.00
BRESKVA	0.29	7.00	4	25.98	12.59	2.00	0.29	6.92	4	25.19	12.21	2.01
BUREK	0.30	7.00	4	24.63	12.03	1.95	0.29	5.67	3	20.87	10.10	1.95
CIMET	0.33	6.83	3	22.42	11.55	1.60	0.33	5.89	3	19.74	10.10	1.60
CIPELA	0.27	6.83	3	22.22	10.68	2.09	0.39	6.92	2	19.84	10.04	1.87
CVET	0.28	6.85	4	24.91	12.06	1.97	0.31	6.69	3	21.84	10.84	1.97
ČAJ	0.29	7.00	3	24.49	11.88	1.98	0.28	6.85	3	23.36	11.32	2.08
ČOKOLADA	0.29	7.00	4	24.77	11.99	2.04	0.27	6.83	3	24.15	11.61	2.08
GROŽĐE	0.33	6.94	3	22.89	11.32	1.95	0.33	6.41	3	21.27	10.54	1.96
HLEB	0.27	6.67	4	25.90	12.49	2.01	0.27	6.67	4	25.33	12.20	2.00
JOGURT	0.29	7.00	4	24.42	11.75	1.99	0.30	6.93	4	23.62	11.41	1.95
KAFA	0.25	7.00	4	26.46	12.65	2.13	0.24	6.50	3	24.34	11.68	2.09
KARMIN	0.27	6.00	4	21.84	10.40	2.08	0.33	5.79	2	17.94	8.69	2.06
KIŠA	0.11	6.42	4	27.06	12.30	2.30	0.18	6.00	4	24.47	11.32	2.22
KRUŠKA	0.27	6.94	4	26.44	12.71	2.01	0.26	6.24	4	24.06	11.49	2.11
NARANDŽA	0.23	7.00	4	27.60	13.03	2.17	0.22	6.86	4	27.58	13.00	2.17
PAPRIKAŠ	0.30	7.00	3	24.21	11.93	1.92	0.27	5.92	3	20.74	10.07	1.92
PARADAJZ	0.28	6.83	4	25.46	12.35	2.00	0.27	6.64	4	24.43	11.71	2.09
PIVO	0.29	7.00	3	23.34	11.56	1.98	0.32	5.69	3	18.23	9.10	1.77
SAPUN	0.27	6.59	4	24.78	11.94	1.99	0.32	6.65	3	22.31	11.25	1.77
SENO	0.15	6.06	4	24.67	11.29	2.24	0.28	5.18	2	17.52	8.49	1.90
ŠNICLA	0.28	7.00	4	25.49	12.42	1.97	0.30	6.92	3	23.83	11.72	1.92
VISKI	0.32	6.83	3	22.75	11.19	1.94	0.41	5.07	1	14.99	7.38	1.79
SLON	0.28	7.00	3	21.53	10.21	2.20	0.45	3.08	0	9.60	4.69	1.38
PRASE	0.11	6.92	5	26.63	12.05	2.31	0.13	4.92	1	18.62	8.45	2.24

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