STUDIES IN LANGUAGE AND MIND 2

SELECTED PAPERS FROM THE 4TH & 5TH WORKSHOP ON *PSYCHOLINGUISTIC, NEUROLINGUISTIC AND CLINICAL LINGUISTIC RESEARCH*

UNIVERSITY OF NOVI SAD,
FACULTY OF PHILOSOPHY,
21000 Novi Sad,
Dr Zorana Đinđića 2
www.ff.uns.ac.rs

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PREFACE

The publication before you represents a small but very valuable portion of papers presented at the 4th and 5th Novi Sad workshop on *Psycholinguistic, neurolinguistic and clinical linguistic research*, held at the University of Novi Sad in April 2016 and 2017. We are delighted to see that the circle of researchers gathering at these workshops in Novi Sad to exchange ideas and to report on the results of their ongoing projects is ever growing. In its five editions, the Workshop has brought together senior and junior scientists working in the multidisciplinary field of Neurocognition of language. In 2016, we had the honour to welcome experts and students from the United Kingdom, USA, Holland, France and Serbia and the latest workshop featured presentations by colleagues from Slovenia, Croatia, Germany, Turkey, Denmark, Holland and Serbia. The fact that our community is growing suggests not only that the interdisciplinary approach to researching the neurocognitive foundation of language in linguistically non-impaired and impaired populations is gaining ground in this part of the world but also that the talks delivered at the Novi Sad workshop represent high-quality research. We would like to believe that the friendly atmosphere we tried to create at the Workshop sparkled the interest of the participants and kept them alert throughout this very dynamic one-day event.

The volume contains five chapters - four research papers and a squib. The squib is a new type of publication, intended primarily for early career researchers (MA and PhD students), who are less versed in writing up scientific papers. It is shorter in form than a research paper and is exptected either to summarize the existing literature on a topic in an attempt to explain the current state of understanding on the topic or to address a problem without necessarily proposing a solution to it but bearing clear relevance to theoretical issues. Each of the manuscripts 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 theoretical contributions followed by papers on language acquisition and acquired language disorders. The opening chapter,

Number, relative frequency, entropy, redundancy, familiarity and concreteness of word senses: Ratings for 150 Serbian polysemous nouns by Dušica Filipović Đurđević and Aleksandar Kostić, reports on the results of a series of surveys conducted in order to collect various ambiguity measures for 150 polysemous nouns selected from a dictionary of Serbian. Native speakers were then asked to list all of the senses of these words they could think of, based on which the authors next elicited concreteness judgments for individual senses of words, as well as word familiarity, and word concreteness judgments. The procedure applied in collecting senses enabled the authors to estimate not only the number of senses of words but their individual frequencies, too. The results of the study show a high correlation between sense frequencies and sense familiarity ratings. Word familiarity and word concreteness are found to be related to the familiarity/concreteness of the dominant sense, which suggests that during the process of making a judgment on certain aspects of a word, participants mostly rely on its dominant sense. In addition, concrete senses were found to be listed more frequently and were rated as more familiar, which is a conclusion that brings us one step closer to understanding the way word senses are represented and processed.

Chapter 2, *Unaccusative, transitive and anti-causative verb production in the process of language acquisition* by Nina Ilić Matijević, aims to contribute to the nativist vs. constructivist debate to language acquisition by examining the order in which verbs with different argument structure are acquired (unaccusative, transitive and anti-causative verbs) in Serbian. The results of this transversal research, conducted with a total of eighteen subjects belonging to six age groups and involving twelve verbs (four verbs from each group) indicate that syntactically more complex verbs are acquired after less complex ones. Regarding the debate concerning the acquisition of unaccusatives, the author claims that the results of this study do not seem to support the maturational delay of A-chains, as unaccusative verbs were produced even by the youngest participants. However, she is also careful to note that no overt morphological or syntactic differences were noted in the usage of unergative and unaccusative verbs in Serbian, which is why no definitive claims can be made

regarding the children's (in)ability to distinguish between unergative and unaccusative verbs at the earliest age. Also, it remains unclear at this point what exactly the difficulty with anti-causative verbs can be attributed to. However, the fact that the participants used adequate tense morphology on the verbs from the earliest age is taken to suggest that they can recognize verbs as members of a coherent syntactic category, which in turn seems to support the nativist approach and speak against the usage-based account, suggesting that learning is item-based and that very young children are unable to make generalizations.

Still within the realm of language acquisition, in Chapter 3 Livia Šagi aims to determine the acquisition process of word order in Hungarian as well as the ordering of arguments based on their information status. Also, in the contribution entitled *The process of word order acquisition and the information status of arguments in English and Hungarian* the author compares the process of word order acquisition in English, which does not have a rich inflectional system and therefore has a rather fixed word order with Hungarian, a language with rich inflectional morphology in which word order is flexible and its main function is to encode pragmatic information. The existing literature on word order acquisition in English reports that children generally tend to adhere to the default SVO order of English from the beginning of the two-word stage and that young children prefer ordering the elements from discourse-new information to discourse-old information. The analysis of Hungarian data, gathered from the CHILDES database, support the initial hypothesis that Hungarian children use every variation of word order, though they prefer the default SVO and SOV orders. Regarding the ordering of arguments according to their information status, the author concludes that both English and Hungarian children tend to put arguments referring to discourse-new information first, followed by arguments referring to old information, i.e. regardless of the type of language (analytic vs. synthetic-agglutinative) , there is a general tendency to order elements from new to old information.

In *Grammatical verbs in Spanish-speaking individuals with aphasia*, co-authored by Silvia Martínez Ferreiro, Byurakn Ishkhanyan, Vicente Rosell-Clarí, and Kasper Boye, the reader is presented with an

in-depth analysis of grammatical verb forms in a set of 24 Spanish-speaking individuals, with and without brain damage. The aim of the chapter is to show that the classification of linguistic items as functional/grammatical or content/lexical in grammar is both theoretically and clinically relevant. Namely, it has recently been argued that some parts of speech are heterogeneous with respect to the grammar-lexicon distinction, and that the classes of e.g. verbs, pronouns and prepositions comprise both grammatical and lexical members. Since individuals with non-fluent aphasias tend to have more problems with grammatical elements, while individuals with fluent aphasias, conversely, have more problems with lexical elements, the research presented in this chapter focused on individuals with mixed and transcortical cases of aphasia and on copulas, light verbs and auxiliaries, including modals, aspectuals and temporal forms. These verb forms seem to resist focalization (outside corrective contexts) and are therefore taken to be grammatical. The lack of statistical differences between the aphasia groups (fluent-non-fluent, mild-moderate) is attributed to the size of the sample but also to the dual nature of the symptoms of participants with mixed aphasia. Still, in these cases, diversity measurements (number of repetitions and type/token ratios) were found to capture the fluent-non-fluent distinction more accurately than those focusing on number of occurrences (presence of finite and non-finite forms).

Finally, Johanne Nedergaard's squib, *Semantic knowledge in the brain: Access, integration and storage*, gives a brief overview of investigations into the question of how semantic knowledge, the aspect of human memory that holds general information about word meanings, facts, objects, and people without connection to a particular point in time or space, is accessed and represented in the brain, with particular focus on verbal/lexical access. Given that there is no general concensus regarding the nature and the location of storing semantic knowledge, the author presents arguments in favour of the view that semantic knowledge is widely distributed with a hub located in the anterior temporal lobe (ATL) and examines evidence from lesion studies, neuroimaging studies, word elicitation studies, and interference studies with healthy participants. She assesses the theoretical

importance of lexical access effects (primarily frequency, age-of-acquisition, and semantic priming), semantic dementia, and category-specific semantic deficits such as the dissociation between semantic knowledge about living and non-living entities and concludes that there is support for the idea that semantic knowledge is represented according to associative networks crucially related to sensory modality, but that this distributed network is connected to a hub located in the anterior temporal lobe, where information is integrated and where we form coherent concepts and compare similarities.

At the end of this preface, we would like to announce that the 6th Novi Sad workshop on *Psycholinguistic, neurolinguistic and clinical linguistic research* will be hosted by the Faculty of Philosophy, University of Novi Sad on April 21, 2018. We hope to welcome both early career and already established scientists eager to present the results of their research.

The Editors,
Novi Sad, November 2017

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The success of the Novi Sad workshops on *Psycholinguistic, neurolinguistic and clinical linguistic research* as well as the publication of this volume is due to many great people. The Editors would like to acknowledge the generous support of the Dean's Office of the Faculty of Philosophy. We wish to extend our gratitude to all those who helped make the workshop the success it was – our invited speakers, Dr Alexandra Perovic (UCL, United Kingdom), Dr Christina Manouilidou (University of Ljubljana, Slovenia) and Dr Aleksandar Kostić (University of Belgrade, Serbia) for their illuminating lectures, all the speakers at the 4th and 5th Novi Sad workshop on *Psycholinguistic, neurolinguistic and clinical linguistic research* for bringing new perspectives to the field, our enthusiastic volunteers and the audiences at both events.

We thank Professor Maja Marković, Head of the English Department and the Organizing Committee for their commitment. We are grateful to the reviewers of this volume and of individual papers for their time and constructive comments, which we believe have greatly improved the quality of this publication. Last but not least, we would like to thank all the contributors to this volume for sharing the results of their work with us and thus inspiring progress in this interdisciplinary field.

Dušica Filipović Đurđević
Department of Psychology, Faculty of Philosophy, University of Novi Sad
dfdurdevic@ff.uns.ac.rs

Aleksandar Kostić
Department of Psychology, Faculty of Philosophy, University of Belgrade
akostic@f.bg.ac.rs

UDC 811.163.41'371:81'23

NUMBER, RELATIVE FREQUENCY, ENTROPY, REDUNDANCY, FAMILIARITY, AND CONCRETENESS OF WORD SENSES: RATINGS FOR 150 SERBIAN POLYSEMOUS NOUNS[*]

Abstract: We collected several measures of ambiguity for 150 Serbian polysemous nouns. Ambiguity measures were derived separately for dictionary senses, and the senses provided by native speakers. In a sense collection task, participants listed all senses of the given word they could think of. Collected senses were categorized in two ways – by preserving fine grained semantic intuition of the speakers as much as possible, and by mapping them onto dictionary categories. In addition, we collected familiarity and concreteness ratings of each dictionary sense, and each sense provided by participants. Based on the senses provided, we calculated the number of senses, the proportion of each sense, entropy and redundancy of sense probability distribution. In order to control for the possible influence of idiosyncratic answers, all ambiguity measures were additionally corrected based on sense frequencies and familiarity ratings. Finally, participants rated word familiarity and word concreteness. The provided measures are to be applied in the research of the processing of polysemous words with a specific accent on the processing effects of meaning uncertainty and balance of sense probabilities. Additionally, they are to help understand the relation between concreteness and polysemy, the relation between semantic intuition and dictionary senses and so forth. All of the collected senses, their frequencies,

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familiarity and concreteness ratings, as well as lexical ambiguity measures, word familiarity and word concreteness ratings are provided in the supplementary material.

Key words: polysemy, number of senses, entropy, redundancy, sense probability, sense familiarity, sense concreteness

1. Introduction

In the research dedicated to the effect of number of meanings on the processing of polysemous words, number of meanings has been determined in several ways. According to the source they rely on, traditional procedures applied to estimate the number of word meanings could be divided in two groups: the ones that rely on dictionaries and the ones that rely on native speakers. More recently, a third line of procedures has been introduced – the line that encompasses techniques of quantitative linguistics. In that approach, word ambiguity is estimated automatically, based on large language corpora (Landauer and Dumais, 1997; Lund and Burgees, 1997; McDonald, 2000; Schütze, 1998). However, these techniques suffer from numerous problems and have not yet replaced human intuition. Therefore, in this paper, we will focus on traditional procedures (see Filipović Đurđević & Kostić, 2009 for the application of quantitative linguistic approach of distributional semantics to polysemy in Serbian).

1.1 Dictionary meanings

In the first studies dealing with word ambiguity the authors usually relied upon unabridged dictionaries when estimating number of meanings (Gernsbacher, 1984; Jastrzembski and Stanners, 1975; Jastrzembski, 1981; Rodd, Gaskell, & Marslen-Wilson, 2002). This approach has been revived recently with the development of software for meaning collection (Armstrong, Tokowicz, & Plaut, 2012). Dictionary meanings are very suitable for use because they are systematized and accessible. However, there are several problems related to the technique of dictionary based determining of number of

meanings. Firstly, there are large differences among different dictionaries in the way they present word meanings. The origin of these differences lies in the different author's approach to the criterion of grouping of certain word meanings. Consequently, different numbers of meanings are estimated based on different dictionaries. The other problem is the fact that in the dictionaries all the known meanings are listed, among which are often those that are no longer in use, or are known to a very small group of people (e.g. archaisms, localisms, specialized terms, etc.). Gernsbacher (1984) found that even very educated individuals, such as university professors, could not list all the meanings listed in the dictionaries. At the same time, some modern and recent word meanings are not listed in the dictionaries. A study conducted with a purpose to explicitly compare meanings listed in the dictionary with the meanings provided by speakers showed that the two groups differed in both meanings and contents (Lin & Ahrens, 2005). In general, this study showed that a slightly larger number of word meanings were listed in the dictionaries, but only part of dictionary meanings corresponded to the customary meanings. The rest of the meanings listed by the participants were new meanings that have developed in the course of language evolution.

1.2 Meanings provided by native speakers

As an alternative source of data for the number of word meanings, some authors suggested the speakers of the language in question (Azuma & Van Orden, 1997; Borowsky & Masson, 1996; Ferraro & Kellas, 1990; Gawlick-Grendell & Woltz, 1994; Gilhooly & Logie, 1980a; 1980b; Hino & Lupker, 1996; Kellas, Ferraro & Simpson, 1988; Millis & Button, 1989; Rubenstein, Garfield & Millikan, 1970; Twilley, Dixon, Taylor, & Clark, 1994). Millis and Button (1989) proposed the term accessible polysemy to denote the number of meanings familiar to native speakers, while Lin and Ahrens (2005) named it semantic intuition. We could distinguish three groups of techniques that rely on the intuition of native speakers: a) subjective ambiguity rating, b) listing of the first meaning and c) listing of all the familiar meanings.

1.2.1. Subjective ambiguity rating

One way to compare unambiguous and ambiguous words was to ask participants to estimate, on a three point scale, for each word whether it had one, two or three meanings (Borowsky & Masson, 1996; Ferraro & Kellas, 1990; Hino & Lupker, 1996; Kellas, Ferraro, & Simpson, 1988). In addition to providing only the basic information about ambiguity, this procedure had several other disadvantages. For example, Lin and Ahrens (2005) stated that there is a possibility that participants did not think enough about all the meanings when making a decision, at least not to the same extent as in the task with listing of all the meanings. Additionally, the criteria used by the participants when making a decision remain unknown. Finally, in the group of words estimated as ambiguous words, large oscillations in the number of meanings were being neglected.

1.2.2. Listing of the first meaning

Another way to get an approximation of the number of meanings was by asking the participants to list the first meaning they could think of (first meaning metric; Forster & Bednall, 1976; Gawlick-Grendell & Woltz, 1994; Gilhooly & Logie, 1980a; Rubenstein, Garfield & Millikan, 1970; Twilley et al., 1994). Independent evaluators would then analyze participants' responses, classify them and determine the number of different responses. However, the results of the experiments examining the effect of the number of meanings estimated in this way are inconsistent. Depending on the choice of stimuli and the degree of difference in the number of meanings, the ambiguity effect was present in some cases (Rubenstein, Garfield & Millikan, 1970), but not in others (Forster & Bednall, 1976). As Millis and Button (1989) stated, the basic disadvantage of this measure is the fact that by noting down the first meaning the participants can think of, only a small number of dominant meanings is collected, while some less frequent meanings are overlooked. By this procedure, words with one dominant meaning are proclaimed unambiguous words, whereas words with more equally frequent meanings are classified as ambiguous.

1.2.3. Listing of all familiar meanings

In order to solve the problem of neglecting non-dominant meanings present in the procedure of first sense listing, some authors suggested asking the participants to list all the meanings they could think of (Azuma, 1996; Millis & Button, 1989). Afterwards, independent evaluators would classify collected meanings and determine the total number of different meanings listed by all the participants (total meaning metric), and average number of meanings per participant (average meaning metric). In three lexical decision task experiments Millis and Button (1989) tested the three ambiguity measures. Their findings showed that the assessment of number of meanings based on listing of the first meaning was not adequate. Contrary to that, the number of senses assessed on the basis of listing of all the familiar meanings proved as a significant predictor of lexical decision latencies. Significant effect of the number of meanings was observed both for total meaning metric and for average meaning metric. Azuma (1996) suggested the use of total meaning metric, and in support of this idea she stated that it would be impossible for the participant to recollect all of the familiar meanings in a short period of time. She suggested that the set of word meanings should be formed based on all the meanings listed by all the participants, with an additional step in which the participants would rate the familiarity of each of the collected meanings. A study conducted by Azuma showed that familiarity rating of word meanings was a useful supplement to the procedure of full listing of familiar meanings.

Frequencies of individual meanings were often available in the mentioned studies and were used to indicate the existence of the dominant meaning, that is the meaning with the highest frequency. However, Gilhooly and Logie (1980a) suggested a more detailed ambiguity measure based on the overall distribution of frequency of meanings. They named this measure meaning uncertainty (U) and they interpreted it as an average uncertainty of the dominant meaning, which is equivalent to entropy of probability distribution of word meanings. This measure was later adopted by Twilley et al. (1994), and several variations have been proposed in the following years. For

example, Armstrong, Tokowicz, & Plaut (2012) proposed largest relative meaning frequency, or β to describe meaning dominance.

1.3. Current study

When estimating lexical ambiguity the authors of the early studies mostly overlooked the difference between homonymy and polysemy. Starting from the finding that polysemy and homonymy are processed differently (Beretta, Fiorentino, Poeppel, 2005; Klepousniotou, and Baum, 2007; Klepousniotou, Pike, Steinhauer, & Gracco, 2012; Rod, Gaskell, and Marslen-Willson, 2002), we have set our focus exclusively on polysemous nouns. Polysemous nouns are the ones with several related senses (e.g. paper), whereas homonymous nouns have several unrelated meanings (e.g. bank). Unlike homonymous nouns, which take more time to process than unambiguous nouns, polysemous nouns are processed faster.

Having in mind the finding that entropy (MacKay, 2003; Shannon, 1948) has proven as a strong predictor of processing latencies at various levels of descriptions of language (e.g. Baayen, Feldman, and Schreuder, 2006; Baayen, Milin, Filipovic Đurđevic, Hendrix, and Marelli, 2011; Balling, and Baayen, 2012; Milin, Filipović Đurđević, and Moscoso del Prado Martìn, 2009; Mosocoso del Prado Martin, Kostić and Baayen, 2004; Tabak, Schreuder, and Baayen, 2005; Wurm, Ernestus, Schreuder, and Baayen, 2006), we have set as the basic goal of this paper the estimation of the entropy of word sense probability distribution (1).

(1)

$$H(w) = -\sum_{i=0}^{n} p_i \cdot \log\, p_i \quad (1)$$

In (1) H denotes entropy of the polysemous word w, index i stands for different senses of word w, p_i denotes the proportion (relative frequency) of the given sense of w, and n denotes the number of senses of w. This measure provides a more detailed index of word

ambiguity (or degree of ambiguity [U] as suggested by Gilhooly and Logie [1980a]). When compared to the number of senses that has been traditionally applied in polysemy research, the added information that is included in entropy concerns the balance of sense probabilities. Entropy of sense probability distribution can be interpreted as uncertainty of senses. It is influenced by the number of senses in such a way that a larger number of senses leads to larger entropy, that is a larger degree of uncertainty of the true sense of the word (with logN being the theoretical maximum). However, it is also influenced by the balance of sense probabilities in that words with balanced probabilities of senses carry greater sense uncertainty, that is larger entropy. Words with a dominant sense, that is unbalanced sense frequencies carry less uncertainty of the true sense of the word. This added information can be described independently of the number of senses via the Information Theory measure of redundancy (2).

(2)

$$T(w) = 1 - \frac{H(w)}{\log N} \quad (2)$$

In (2) T(w) stands for the redundancy of the polysemous word w, H(w) stands for its entropy, and N denotes the number of senses of word w. The larger the redundancy, the less balanced the distribution of sense probabilities, that is the less the uncertainty of the true sense of the word.

The approach of describing polysemy as sense uncertainty brings an advantage, as suggested by Gilhooly and Logie (1980a), as it offers a more detailed description of the degree of ambiguity. Additionally, separate quantification of the two sources of sense uncertainty, namely number of senses and redundancy (balance of sense probabilities), brings the additional advantage of separate investigation of the influence that these can have on the processing of polysemous words. Polysemous words need not be categorized into words with a dominant sense and words with a balanced sense, as was the case previously (Duffy, Morris, & Rayner, 1988; Klepousniotou, Titone, Romero,

2008; Simpson, 1994; Swinney, 1979; Whitney, Jefferies, & Kircher, 2011) – the degree of balance of sense probabilities can be controlled or investigated in a more detailed manner.

Our approach is similar to the one of Gilhooly and Logie (1980a). However, unlike their study in which the participants listed the first meaning they could think of, in this study we asked participants to list all the senses they could think of (as suggested by Azuma, 1996) and offered several corrections of the estimated number of senses based on several criteria. Also, in addition to calculating entropy of the dictionary senses listed by the participants, as was done by Gilhooly and Logie (1980a), we calculated entropy of the raw senses listed by the participants (without categorizing them based on the dictionary senses). Finally, in addition to calculating entropy, we calculated redundancy of the distribution of sense probabilities.

With all of the previously described approaches in mind, the estimation of the number of senses of Serbian polysemous words was performed in several ways. Firstly, based on the senses stated in an extensive dictionary of Serbian a sample of 150 polysemous Serbian nouns was excerpted. For each noun we collected familiarity ratings (subjective frequency) and word concreteness ratings. After that, for each of these nouns, we collected all the senses that the participants, native speakers of Serbian language, could think of. Additionally, the collected senses were categorized in compliance with the senses listed in the dictionary. The number of senses was estimated in two ways. On the one hand, the number of senses listed by the participants was determined, and on the other hand, the number of dictionary senses that were being listed by the participants was determined. In addition to the number of senses (N), frequencies of listing each sense were determined. Based on the number of participants listing a specific sense (sense frequency), we derived a proportion (relative frequency) of the sense in question in relation to other word senses (p). Entropy and redundancy are derived from determined proportions by applying (1) and (2).

In the next step, we collected familiarity ratings separately for the senses listed in the dictionary and the senses listed by the participants. Based on these ratings, the estimated number of senses

was corrected by excluding from the set of senses those senses that were not familiar to the majority of the participants. Additionally, we collected concreteness ratings for individual senses (separately for the ones listed in the dictionary and the ones listed by participants).

A summary of the collected ratings can be found in the Appendix and the supplementary material containing the full dataset can be accessed online.[1]

2. Dictionary based number of senses

In this study, the dictionary based number of senses was used as a starting point. This measure has been used in a large number of studies, in spite of the numerous downsides that are related to this technique of estimating the number of senses (Armstrong, Tokowicz, & Plaut, 2012; Gernsbacher, 1984; Jastrzembski, 1981; Jastrzembski and Stanners, 1975; Lin and Ahrens, 2005; Rodd et al., 2002).

2.1 Method

2.1.1. Stimuli

Based on *Rečnik Matice srpske* dictionary (the most extensive completed dictionary of Serbian), 150 Serbian nouns were selected that have several senses listed in one dictionary entry, that is which satisfy the criterion of polysemy stated by linguists (it is common to consider separate entries as separate lemmas [Rodd et al., 2002]). Only the words that do not overlap with various inflected forms of other

[1] All collected senses and their associated measures can be found following this link: https://drive.google.com/file/d/0B0HHGsBbpIrleVY1U3l0LTRWMTA/view?usp=sharing
Per-word summary of collected measures can be found following this link: https://drive.google.com/file/d/0B0HHGsBbpIrlN29ja0cxQzAycWM/view?usp=sharing

word classes were selected to insure the investigation of strictly polysemous nouns (for example, the noun *baza* [base] is excluded due to being a homograph with one of the present tense forms of the verb *bazati – on baza* [to wonder around – he wonders around]). Therefore, all of the selected stimuli were strictly polysemous Serbian nouns. The words were selected to span as high as possible a range of number of senses, and lemma frequencies obtained from a frequency dictionary (Kostić, 1999). An attempt was made to decorelate number of senses and lemma frequencies by matching the words for their lemma frequencies (as closely as possible) accross the categories of words with a given number of senses

2.1.2. Procedure

The number of senses was established in two ways. Firstly, by counting all of the senses, regardless of the grouping assigned by the authors of the dictionary. For example, this way, the word *gluma* (an act) had four senses. Also, the number of senses was determined by counting the clusters of senses, as stated in the dictionary. This way, the same word had three senses (Table 1).

Table 1. Rečnik Matice srpske dictionary description of word *gluma* (an act).

gluma (an act)	1	skill of an actor (*His act was very good in that movie*.)
	2a	a theatre play (*I went to the theatre to see the new act.*)
	2b	theatre art (*The act in Belgrade is very good.*)
	3	(figurative) pretending (*Do not trust him, it is all an act!*)

2.2. Results and discussion

Distributions of the two measures of number of senses are shown in Table 2. The selected polysemous nouns had on average 6.71 senses when all of the senses were taken into account, and 4.51 clusters of senses. There was a significant correlation between the two counts ($r=.748$, $p<.001$).

Table 2. The distribution of the number of senses listed in the dictionary. Rows refer to number of senses given in the first column; the second column illustrates how many words have the given number of individual senses and the third column contains average lemma frequencies of those words; the fourth column contains number of words that have a given number of sense clusters and the fifth column contains their average lemma frequencies. The two final rows contain the mean and the standard deviation of values presented in the respective columns.

	Individual senses		Clusters of senses	
Number of senses	Number of words	Mean lemma frequency	Number of words	Mean lemma frequency
1			2	79.00
2	12	241.17	21	187.67
3	14	127.71	33	140.33
4	20	143.15	37	217.68
5	16	197.81	15	226.20
6	21	202.29	16	190.56
7	16	163.06	8	230.88
8	9	200.22	9	344.00
9	12	271.75	7	271.00
10	6	226.83		
11	10	293.50	1	176.00
12	4	351.50	1	365.00
13	4	287.00		
14	3	198.67		
15	1	60.00		
18	2	235.50		
M	6.71		4.51	
SD	3.42		2.14	

Levene's test of homogeneity of variance demonstrated that frequency was equally distributed across the categories of number of senses. However, in spite of this, there was a significant correlation between lemma frequency and the number of all of the senses listed in the dictionary ($r=.184$, $p<.05$).

3. Collecting word familiarity ratings and ratings of the senses listed by native speakers

Having in mind all the downsides of using a dictionary in estimating the number of senses, we also collected measures of so called accessible polysemy (Millis & Button, 1989), that is we conducted a study aimed at estimating the number of senses that are accessible to participants. Having in mind the downsides and the unreliability of the technique in which participants list only the first meaning they can think of, in this study participants were asked to list all of the senses they could think of (Azuma, 1996; Millis & Button, 1989).

3.1 Method

3.1.1. Participants

Seventy-four first year and second year students from the Department of Psychology, Faculty of Philosophy at the University of Belgrade participated in the study. Some of them also took part in the remaining studies that we reported in this manuscript.

3.1.2. Stimuli

The words selected from *Rečnik Matice srpske* dictionary were divided in five groups, in such a way that the average number of dictionary senses was equal across groups. Word groups were printed in separate ten-page booklets. In each booklet, words were printed in five random orders. Next to each word, a seven point word familiarity

rating scale was printed, and an empty space for listing senses was placed.

3.1.3. Procedure

Each participant filled only one booklet, that is listed the senses for one group of 30 words. The first page of the booklet contained a detailed instruction and an example. The task of the participant was to read the word and rate its familiarity (how often he/she encountered the word) on a seven-point scale. Number one marked a word that was completely unfamiliar, while number seven marked a word that was very familiar:

COMPLETELY UNFAMILIAR WORD 1 2 3 4 5 6 7 VERY FAMILIAR WORD

After that, the task was to list all of the senses of a word the participant could think of, using the empty space below each word (various concepts denoted by a word, various usages of the concept, etc). Participants were advised to rely on as many means as possible while listing the senses, such as the definition of meaning, a synonym, a sentence illustrating the usage, and so forth.

3.2. Results and discussion

All of the words were rated as highly familiar. The average familiarity for 150 polysemous nouns was 6.28 units of the seven point scale (SD=.48). Senses of each word were collected based on the descriptions of 17 to 19 participants (group 1: N=17; group 2: N=18; group 3: N=19; group 4: N=18; group 5: N=19). We derived measures of the total number of senses listed by the participants and the average number of senses per participant. Distributions of the collected measures are listed in Table 3. Total and average number of senses was determined in two ways. On the one hand, we calculated the number of raw, uncategorized senses listed by the participants, and on the other

hand, we calculated the number of senses that matched one of the senses listed in the dictionary.

The raw number of senses was determined by considering each of the senses listed by the participants as a separate sense (Azuma, 1996). Senses were kept separate even when they were a more specific instance of a more general sense. This decision was made in order to preserve a fine grained semantic distinction. For example, very often there were notable differences between the characteristics of the objects denoted by a general, and those denoted by a more specific instance of a particular word sense. In accordance with this view is Azuma's finding that a large number of participants stated separately general senses and their specific instances. This rule was broken only when it was obvious that the participant defined the same sense in several manners. In order to avoid the possibility of listing idiosyncratic senses, we calculated the number of senses listed by more than 10% of the participants. In our case, this means that senses listed by only one participant were excluded from the list.

In addition to the number of raw senses listed by the participants, we calculated the number of dictionary senses listed by the participants. This was done by categorizing the raw senses listed by the participants according to the dictionary, that is by matching each sense listed by the participants with an adequate dictionary entry. After that, we counted the dictionary entries that appeared in the participants' answers.

Participants listed 2.94 senses on average, 2.23 of which were listed in the dictionary. On the one hand, a slightly larger number of the raw senses listed by the participants was a consequence of the applied principle of keeping the variety of answers in counting the word senses. This principle led to a more fine grained, or higher "resolution", and consequently to a larger number of senses. On the other hand, this difference was a consequence of the existence of senses listed by the participants but not appearing in the dictionary. The two estimated measures of number of senses were moderately correlated ($r = .49$, $p < .01$).

The average number of senses listed per word was 12.51. After eliminating senses listed by less than 10% of participants (i.e. listed by only one participant) the average total number of senses listed by

participants was 7.97. The correlation of the number of senses listed by the participants before and after eliminating idiosyncratic answers was positive, and statistically significant ($r=.80$, $p<.01$). We recorded a significant correlation between the total and the average number of senses per participant (before eliminating rare answers: $r=.76$, $p<.01$; after eliminating rare answers: $r=.78$, $p<.01$). The number of senses listed per participant was moderately correlated with the number of senses listed in the dictionary (before eliminating rare answers: $r=.40$, $p<.01$; after eliminating rare answers: $r=.33$, $p<.01$).

After categorizing the senses according to the dictionary entries, the average number of listed senses was 4.41. After eliminating the senses listed by less than 10% of the participants, the average number of listed senses decreased to 3.97. The two measures of number of senses were highly correlated ($r=.95$, $p<.01$). On average, participants listed 2.23 senses listed in the dictionary. The total number of dictionary senses listed by the participants and the average number of dictionary senses per participant were moderately correlated ($r=.56$, $p<.01$, regardless of eliminating rare answers). As expected, the correlation between the number of senses listed in the dictionary and the number of dictionary senses listed by participants was higher than the correlation between the number of senses listed in the dictionary and the number of raw senses listed by the participants (before eliminating rare answers: $r=.82$, $p<.01$; after eliminating rare answers: $r=.77$, $p<.01$).

Table 3. The distribution of the number of senses listed by the participants, prior to categorization (left hand side) and after being categorized according to the dictionary (right hand side). Rows mark the number of senses listed in the first column, and cells contain the number of words with a given number of senses: the total number of listed senses (Total), the number of senses listed by more than 10% of the participants (Total>10%), the average number of senses per participant (M), the most frequent number of senses per participant (mode), and the median number of senses per participant (median). The final two rows contain the mean and the standard deviation of values listed in the respective columns. For example, number 59 in the second row and the fifth column states that there were 59 words for which the mode of the number of senses listed by the participants was 2 (i.e. that there were 59 words for which the participants most frequently listed 2 senses).

	Number of words with the given number of senses (as listed in the first row)									
	Raw senses listed by participants					*Dictionary senses listed by participants*				
Number of senses	Total	Total >10%	M	Mode	Median	Total	Total >10%	M	Mode	Median
1			1	1	1	2	2	14	15	14
2			37	59	45	25	30	94	95	95
3		4	83	61	77	32	33	37	34	35
4	1	8	25	25	24	31	37	5	5	6
5	2	16	4	3	3	23	26		1	
6	11	18		1		12	8			
7	7	31				11	7			
8	14	22				5	5			
9	10	13				6	1			
10	12	10				2	1			
11	15	9				1				
12	13	7								
13	13	3								
14	9	6								
15	9	1								
16	8	1								
17	4	1								
18	3									
19	4									
20	5									
21	1									
22	1									
23	1									
24	1									
25	5									
34	1									
M	12.51	7.97	2.94	2.82	2.85	4.41	3.97	2.23	2.21	2.20
SD	5.07	2.84	.70	.84	.73	2.08	1.70	.56	.69	.65

In addition to counting the number of senses, the applied procedure of collecting senses enabled us to calculate the frequency of each sense, i.e. the number of participants who listed a given sense. Based on frequency, we calculated the proportion of each sense, relative to all listed senses. In the next step, based on the proportions, we calculated Information Theory measures describing the characteristics of the whole distribution. These measures were entropy and redundancy. Considering the fact that we counted the number of senses in several ways, both entropy and redundancy were calculated for each of the obtained number of senses, that is for: a) raw senses listed by the participants, b) raw senses listed by more than 10% of the participants, c) dictionary senses listed by the participants, and d) dictionary senses listed by more than 10% of the participants.

The number of senses listed in the dictionary and the number of senses listed by the participants, along with corresponding entropies and redundancies of sense probability distributions are listed in the supplementary data.

4. Collecting familiarity ratings for dictionary senses

In spite of the numerous downsides, the number of senses listed in the dictionaries should not be discarded. The classification criteria applied in the dictionaries reflect important aspects of linguistic semantic theories. Taking into account the significance of the theoretical basis for estimating the number of senses, we conducted a study aimed at overcoming some of the downsides of the dictionary based estimation of the number of senses. The most common critique refers to the fact that dictionaries list many of the senses that are unfamiliar to average speakers (Gernsbacher, 1984; Lin & Ahrens, 2005). Overcoming this downside by categorizing the senses listed by the participants according to dictionary senses requires a high level of linguistic competence or expertise and introduces new problems. Therefore, the estimated numbers of senses were corrected by collecting sense familiarity ratings. We conducted a study in which participants rated the familiarity of each sense listed in the dictionary. This way, the number of senses listed in

the dictionary was transformed to the number of dictionary senses that are familiar to the majority of the participants.

4.1. Method

4.1.1. Participants

Ninety-one first year students from the Department of Psychology, Faculty of Philosophy at the University of Belgrade participated in the study. The participants from this study partially overlapped with participants from other studies reported in this paper.

4.1.2. Stimuli

One hundred and fifty words selected in the first phase of the study were divided into four groups in such a way as to keep the average number of senses (as listed in the dictionary) equal across the four groups. The words and senses were printed in three random orders in separate booklets, making nine random orders in total.

4.1.3. Procedure

Each participant filled one booklet, i.e. rated one 35-word group. Each page of the booklet consisted of three columns. The first column contained a word, the second column contained the descriptions of each of the senses taken from the dictionary *Rečnik Matice srpske* (one description per row), while the third column contained a seven point scale printed next to the sense description. The first page of the booklet contained a detailed instruction and an example. The task of the participant was to read all of the listed senses and use the seven-point scale to rate the familiarity of a given sense (how often they have encountered it). If a word sense was very familiar, that is if they have encountered a given word in a given sense often, a 7 was to be circled. If the sense was partially familiar, that is, a given word was sometimes encountered in a given sense, a 3, or 4 was to be circled. On the other hand, if a given sense of a word was completely unfamiliar, that is, if

they have never encountered a given word in a given sense, a 1 was to be circled. The participants were advised to use the whole range of the scale:

COMPLETELY UNFAMILIAR WORD SENSE 1 2 3 4 5 6 7 VERY FAMILIAR WORD SENSE

4.2. Results and discussion

Sense familiarity measures of each word were derived based on the ratings of 20 to 27 participants (group 1: N=27; group 2: N=21; group 3: N=23; group 4: N=22). The distributions of the collected measures are listed in Table 4.

The average number of the senses that are familiar to the participants was calculated by determining the number of senses that were rated above 1 on the familiarity scale. This was done for each participant separately, and after that three measures of central tendency were derived for the number of familiar senses (average, mode, and median). The average number of senses that are familiar to the participants was 5.82, which in comparison with the average number of senses listed by the participants (4.41) was in accordance with the assumption that the participants were not listing all of the senses they are familiar with (cf. Azuma, 1996). In spite of that, the two measures were positively correlated ($r=.65$, $p<.01$).

Table 4. The distribution of the total number of senses, and the average number of senses per participant (prior to categorization: left hand side; after being categorized according to dictionary senses: right hand side) based on the sense familiarity judgment, obtained by applying three criteria: counting the senses with the mean sense familiarity rating greater than or equal to 2 (M>=2), counting the senses with the most frequent sense familiarity rating larger than 1 (mode>1), and counting the senses rated by more than 50% of the participants by above 1 sense familiarity (median>1). The rows represent the number of senses listed in the first column, and the cells contain the number of words that have the given number of senses. The final two rows contain the mean and standard deviation of values listed in respective columns.

	Number of words											
	Uncategorized senses listed by participants						*Dictionary senses*					
	Total number of senses			*Average number of senses per participant*			*Total number of senses*			*Average number of senses per participant*		
Number of senses	M ≥2	Mode >1	Median >1	M ≥2	Mode >1	Median >1	M ≥2	Mode >1	Median >1	M ≥2	Mode >1	Median >1
1				3	17	12						
2				4	2	1	14	18	14	14	14	14
3				2			17	22	18	16	18	16
4	1	1	1	2	1	1	21	32	21	26	22	24
5	4	11	4	8	3	4	20	20	24	25	24	23
6	11	11	12	18	12	15	23	15	19	20	21	24
7	5	7	6	10	7	6	12	7	11	10	8	8
8	16	15	16	18	16	18	6	11	7	8	8	6
9	11	14	10	14	10	12	11	9	13	12	13	14
10	15	16	14	4			8	6	7	6	6	8
11	13	12	15	8	14	13	6	3	4	6	7	4
12	12	5	11	7	8	9	6	6	5	4	3	5
13	11	11	10	9	12	10	3		4	2	5	3
14	10	15	11	13	12	15	2		2			
15	10	4	10	8	8	7						
16	7	8	6	4	6	6						
17	5	5	6	6	5	6		1		1	1	1
18	4	3	3	3	4	3	1		1			
19	2	2	2	1	3	3						
20	3	1	3	1								
21	1	1	1		2	1						
22	1	1	1			1						
23	1	3	2	4	2	1						
24	2	1	2	2	2	3						
25	4	2	3		3	2						
30				1								
33						1						
34		1										
35	1		1		1							
M	12.25	11.53	12.16	10.45	10.86	10.96	6.23	5.47	6.15	5.82	6.05	5.98
SD	5.05	5.00	5.04	5.26	6.14	5.73	3.19	2.87	3.18	2.89	3.06	2.96

For each dictionary sense, we derived three measures of central tendency: average, median, and mode of participant's familiarity

judgments. After that, based on each of these measures of central tendencies, we derived a new, corrected number of senses. In case of average-based measures, we counted only senses with a mean familiarity rating equal to or above 2.00. In the case of mode and median-based measures, we counted only the senses with a mode or median familiarity judgment above 1. In other words, we counted only the senses which were rated above 1 by at least half of the participants (median), and only senses that were not rated with 1 in the majority of cases (mode).

As expected, the average number of dictionary senses that was familiar to the majority of the participants was less than the number of senses listed in the dictionary. The resemblance of the two measures was highest in case of counting the senses based on the criterion of average ratings (6.23). The resemblance was weaker in the case of median (6.15), and was the weakest in the case of mode (5.47). Mode was the most strict criterion in accepting the senses familiar to participants.

The comparisons of the three derived measures of the number of dictionary senses familiar to the participants (based on the three measures of central tendency) revealed high positive correlation coefficients between each of the pairs ($r>.95$, $p<.01$). In addition to that, a high positive correlation was observed between the number of senses listed in the dictionary, and the number of dictionary senses with an average familiarity rating of 2 or higher ($r=.96$, $p<.01$), as well as with the number of dictionary senses with a median familiarity rating above 1 ($r=.96$, $p<.01$). The correlation coefficient was somewhat lower in the case of the number of senses with a mode familiarity rating above 1 ($r=.85$, $p<.01$). The three measures were also correlated with the number of dictionary senses listed by the participants. In this case, when compared to the correlation coefficients with the number of senses listed in the dictionary, the correlation coefficient was slightly lower for the senses selected by applying the average-based criterion ($r=.86$, $p<.01$), and the median-based criterion ($r=.86$, $p<.01$), and remained almost unchanged in the case of the mode-based criterion ($r=.88$, $p<.01$).

The correlation coefficient between the average familiarity of word senses and the familiarity rating of the corresponding word was not significant. Word familiarity judgments were correlated only with familiarity judgments of the dominant sense ($r=.32$, $p<.01$).

The average familiarity judgments of the dictionary senses were positively correlated with the dictionary sense frequencies, that is, the number of participants who listed a given dictionary sense ($r=.68$, $p<.01$). In general, familiar senses were more frequently listed (Figure 1). However, there was a large number of low frequency senses that were rated as highly familiar. We could assume that the observed correlation would increase if the number of participants were increased.

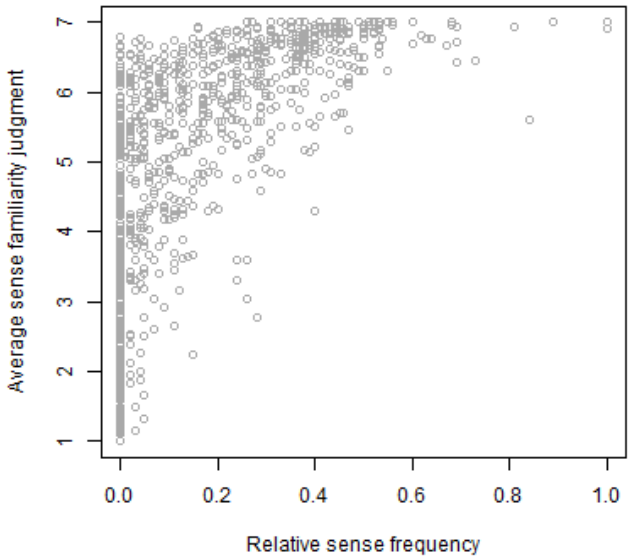

Figure 1: The relation of the relative sense frequencies and the average sense familiarity judgments obtained for the senses listed in the dictionary

5. Collecting familiarity ratings for the senses listed by native speakers

Given that while collecting the raw sense listed by the participants an effort was made to preserve the semantic intuition of the participants as closely as possible, there was a risk of the presence of idiosyncratic senses in the collected sample. To ensure that all of the senses on which the analyses were to be based were familiar to the majority of

participants, we conducted a study in which the participants rated the familiarity of each of the senses previously collected.

5.1. Method

5.1.1. Participants

Eighty-five first year students from the Department of Psychology, Faculty of Philosophy at the University of Belgrade participated in the study. Some of the participants who took part in this study also participated in other studies reported here.

5.1.2. Stimuli

One hundred and fifty words selected in the first phase of the study were divided in four groups, in such a way to keep the average number of senses equal across the four groups. The words and senses were printed in three random orders in separate booklets, making nine random orders in total.

5.1.3. Procedure

Each participant filled one booklet, that is, rated one 35-word group. The task was the same as in rating the familiarity of the senses listed in the dictionary. The only difference was that, instead of the dictionary senses, the raw senses listed by the participants in the first stage of the study were printed next to each word. Along with these senses, five absurd senses were included in the list, in order to control for the potential random filling of the test by the participants.

5.2. Results and discussion

Seven participants who rated either one of the control, nonsense senses as familiar (above 1 on the familiarity scale) were excluded from the sample. Sense familiarity measures of each word were derived based on the judgments of 17 to 22 participants (group 1: N=19; group 2:

N=17; group 3: N=20; group 4: N=22). The distributions of collected measures are listed in Table 4.

The measures of the number of senses listed by the participants, which were familiar to the majority of participants, were derived in the same way as the measures of the number of familiar dictionary senses (previous section).

The average number of raw senses listed by the participants that were familiar to the participants was 10.45, which was higher than the average number of raw senses listed by the participants. However, these two measures were highly correlated ($r=.88$, $p<.01$).

The average total number of raw senses that the participants were familiar with was only slightly below the average total number of the raw senses listed by the participants. This number was lower only if the mode-based criterion was applied in the selection of the familiar senses.

High correlation coefficients were obtained for each of the pairs of the three derived measures of the number of familiar raw senses listed by the participants ($r>.98$, $p<.01$). In addition to that, we obtained a high correlation coefficient between the raw number of senses listed by the participants and the number of raw senses listed by the participants with a mean sense familiarity of 2 or higher ($r=.99$, $p<.01$), as well as the number of senses listed by the participants with a median sense familiarity above 1 ($r=.99$, $p<.01$). The correlation coefficient was slightly lower, but also still very high in the case of the number of senses with a mode sense familiarity above 1 ($r=.97$, $p<.01$). The three measures of the number of familiar senses were also correlated with the number of raw senses listed by more than 10% of the participants. In this case, the correlation coefficient was the same for all three measures and slightly lower ($r=.80$, $p<.01$). A high correlation between the number of listed senses and the number of familiar senses, as well as a decrease in correlation in the case of the number of senses listed by more than 10% of the participants pointed to the absence of idiosyncratic senses in the collected sample. The remaining downside of counting the raw senses listed by the participants was the possibility that a sense listed by only one participant was not distinct enough to be treated as a separate sense.

Word familiarity judgments were positively correlated with the mean sense familiarity judgments ($r=.25$, $p<.01$). Although the

correlation coefficient was significant for mean sense familiarity ratings of the subordinate senses (r=.22, p<.01), it was higher in case of the dominant sense familiarity judgments (r=.30, p<.01).

The average sense familiarity judgments were positively correlated with sense frequency, that is the number of participants listing a sense (r=.68, p<.01). In general, the senses with higher familiarity ratings were listed by a larger number of participants (Figure 2). However, there was a large number of low frequency senses that were rated as highly familiar. This was probably due to the great variety of answers produced by the participants.

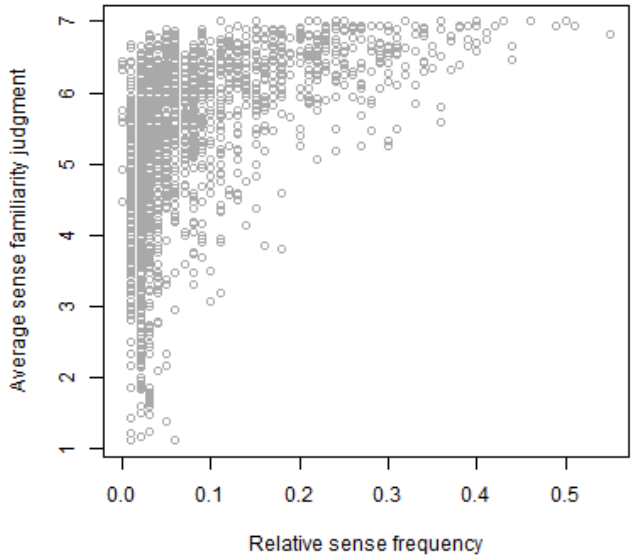

Figure 2: The relation of the relative sense frequencies and the average sense familiarity judgments obtained for the senses listed by the participants

6. Collecting word concreteness ratings

It has been demonstrated that concreteness of word meaning affected processing time. Words denoting objects or beings that could be experienced through the senses (seeing, hearing, touching, etc.) are recognized faster than words denoting abstract concepts (Paivio, 1986;

Schwanenflugel, 1991). Therefore, in order to control for the effect of concreteness, we assessed the word concreteness ratings.

6.1. Method

6.1.1. Participants

Forty-three first year students from the Department of Psychology, Faculty of Philosophy at the University of Belgrade participated in the study. These participants also took part in some of the remaining studies reported here.

6.1.2. Stimuli

One hundred and fifty words selected in the first phase of the study were divided into two groups, and printed in three random orders in separate booklets.

6.1.3. Procedure

Each participant filled only one booklet, i.e. rated one group of 75 words. The first page of the booklet contained detailed instructions and an example. The instructions were formulated based on Paivio, Yuille, and Madigan (1968) and their definition of abstractness as the absence of sensory experience. The task of the participants was to read the word and rate the extent of the possibility to experience the object denoted by a word using the senses, that is, to rate its concreteness. They were required to do so by circling the right value on the scale ranging from 1 to 7. Number 1 referred to a very abstract concept, something one can not see, hear, smell, or touch (e.g. ‘truth’), while number 7 referred to something very concrete, something one can see, hear, smell, touch, etc. (e.g. ‘pig’). Participants were advised to use the whole range of the printed scale:

ABSTRACT 1 2 3 4 5 6 7 CONCRETE

Although imageability is frequently assessed along with concreteness, in this study we opted only for concreteness. We decided to do so by taking into consideration the finding that the correlation between concreteness and imageability is typically high (e.g. r=.83 in Paivio et al., 1968). Additionally, it has been shown that participants typically rate imageability by relying only on visual modality (Connell & Lynott, 2010), whereas all sensory modalities contribute to the representation of word meaning (Filipović Đurđević, Popović Stijačić, & Karapandžić, 2016; Lynott & Connell, 2009; 2010; 2013).

6.2. Results and discussion

For each word, concreteness judgments were estimated based on the answers of around 20 participants (group 1: N=23; group 2: N=21). Average word concreteness of the tested nouns was 4.93 units of the seven-point scale (SD=1.54). More than two thirds of the tested words were rated as concrete, while less than a third was rated as abstract. Word concreteness judgments correlated significantly only with word familiarity ratings ($r=.24$, $p<.01$) and the number of dictionary senses listed by the participants ($r=-.23$, $p<.01$). However, a significant correlation coefficient was obtained for standard deviation of word concreteness judgments and all of the estimated measures of number of senses (e.g., in the case of the number of raw senses listed by the participants: $r=.19$, $p<.05$). This finding matched our expectation that inconsistencies in concreteness judgments would increase with an increase in number of senses based on which one can rate concreteness. In accordance with this interpretation, the participants were informing us about the problems they had while deciding which sense they should rate while rating the concreteness of an ambiguous word.

7. Collecting concreteness ratings for dictionary senses

In addition to the study in which word concreteness ratings were collected, we conducted a study in which participants rated the concreteness of individual senses listed in the dictionary.

7.1. Method

7.1.1. Participants

Eighty-two first year students from the Department of Psychology, Faculty of Philosophy at the University of Belgrade participated in the study. As with the previous studies, this group of participants partially overlapped with participants from the remaining studies.

7.1.2. Stimuli

One hundred and fifty words selected in the first phase of the study were divided into four groups in such way that the average number of dictionary senses was equal across groups. Each group of words was printed in three random orders in separate booklets. At the same time, word senses were printed in three random orders, making nine random orders in total.

7.1.3. Procedure

Each participant filled one booklet, i.e. rated one 35-word group. Each page of the booklet consisted of three columns. The first column contained a word, the second column contained the descriptions of each of the senses taken from the dictionary *Rečnik Matice srpske* (one description per row), while the third column contained a seven point scale printed next to the sense description. The first page of the booklet contained detailed instructions and an example. The task of the participants was to read the word and rate the extent of the possibility to experience the object denoted by the word sense using the senses

(sight, smell, touch…), i.e. to rate its concreteness. They were expected to do this by circling the right value on the scale ranging from 1 to 7. Number 1 referred to a very abstract concept, something one could not see, hear, smell, or touch (e.g. 'truth'), while number 7 referred to something very concrete, something one could see, hear, smell, touch, etc. (e.g. 'pig'). Participants were advised to use the whole range of the printed scale:

ABSTRACT WORD SENSE 1 2 3 4 5 6 7 CONCRETE WORD SENSE

7.2. Results and discussion

For each word, sense concreteness judgments were estimated based on the ratings of around 20 to 21 participants (group 1: N=21; group 2: N=20; group 3: N=20; group 4: N=21). We tested the reliability of the obtained ratings by splitting participants into two groups and looking at the correlation between the average sense concreteness ratings obtained in them. Our results revealed a high positive correlation between the two groups ($r=.89$, $p<.01$), as well as a high positive correlation between each of the groups and the global averages ($r=.97$, $p<.01$). This provided us with the information that the collected judgments were stable across participants.

Word concreteness ratings and average sense concreteness ratings were positively correlated: $r=.68$, $p<.01$. However, this correlation was a concequence of the high correlation between the word concreteness ratings and the dominant sense ratings: $r=.71$, $p<.01$. No significant correlation was recorded between word concreteness ratings and the average concreteness ratings of the subordinate senses. This finding indicated that during the process of rating word concreteness, participants were mostly relying on the dominant sense.

We recorded a significant positive correlation between sense concreteness ratings and sense frequencies, i.e. the number of participants who listed a sense in the first phase of the study: $r=.36$, $p<.01$. A similar relation was recorded in the case of sense concreteness ratings and sense familiarity ratings: $r=.28$, $p<.01$. The

participants were more frequently listing concrete senses. At the same time, they demonstrated a tendency to rate concrete senses as more familiar.

8. Collecting concreteness ratings for senses listed by native speakers

In addition to the study in which participants rated the concreteness of the senses listed in the dictionary, we conducted a study in which participants rated the concreteness of the senses listed by native speakers, which were collected in the first phase of the study.

8.1. Method

8.1.1. Participants

Sixty-five first year students from the Department of Psychology, Faculty of Philosophy at the University of Belgrade participated in the study. These participants also took part in some of the other studies we reported in this paper.

8.1.2. Stimuli

One hundred and fifty words selected in the first phase of the study were divided into four groups, in such way that the average number of dictionary senses was equal across groups. Each group of words was printed in three random orders in separate booklets. At the same time, word senses were printed in three random orders, making nine random orders in total.

8.1.3. Procedure

Each participant filled one booklet, that is rated one 35-word group. The task was identical to the one described in the previous

section, the only difference being that instead of dictionary descriptions of the senses, the descriptions listed by the participants were printed.

8.2. Results and discussion

For each word, sense concreteness judgments were estimated based on the ratings of around 15 to 17 participants (group 1: N=17; group 2: N=16; group 3: N=15; group 4: N=17). As in the previous section, we split participants into two groups and observed a high positive correlation between the averages obtained in the two groups ($r=.87$, $p<.01$), as well as between averages from each of the groups and global averages ($r=.97$, $p<.01$; $r=.96$, $p<.01$).

There was a significant correlation between word concreteness ratings and average sense concreteness ratings: $r=.68$, $p<.01$. A slightly higher correlation coefficient was recorded between word concreteness ratings and dominant sense concreteness ratings: $r=.73$, $p<.01$. The correlation coefficient between word concreteness ratings and average concreteness ratings of the subordinate senses was lower: $r=.17$, $p<.05$. As in the case of the dictionary senses, we could infer that the participants made the word concreteness judgments based on the dominant sense of a word.

A moderate positive correlation was obtained between sense concreteness ratings and sense frequencies, that is, the number of participants listing a sense: $r=.30$, $p<.01$. A slightly lower, but significant correlation coefficient was obtained in the case of sense concreteness ratings and sense familiarity ratings: $r=.21$, $p<.01$. Based on this, we can conclude that concrete senses were listed more frequently and rated as more familiar by participants.

9. General discussion

We conducted a series of studies aiming at collecting several ambiguity measures. Based on the senses listed in the dictionary *Rečnik Matice srpske*, we selected 150 polysemous Serbian nouns. The selected words were presented in several surveys. Firstly, we collected

all of the senses that the participants, native speakers of Serbian could think of. Based on the collected sample, we formed two lists of senses, which were subjected to further research. On the one hand, we formed a list of raw, uncategorized senses listed by the participants, and on the other hand, by categorizing the raw senses according to the dictionary, we formed a list of dictionary senses listed by the participants. For each of the two lists, we determined the total number of senses, and the average number of senses per participant. In order to control for the potential influence of idiosyncratic senses, the number of senses was corrected by excluding all of the senses listed by less than 10% of participants, that is, listed by only one participant. In addition to that, for each of the lists of senses, we collected familiarity judgments of individual senses. After that, the number of senses was alternatively corrected by excluding the senses that were unfamiliar to the majority of the participants. In addition to familiarity judgments, we collected concreteness judgments for individual senses, as well as word familiarity, and word concreteness judgments. The procedure we applied in collecting senses enabled us to estimate not only the number of senses, but their frequencies, that is, proportions of individual senses, as well. Based on these proportions we derived Information Theory measures – entropy and redundancy of the sense probability distribution. The collected measures will be the baseline for further research on the processing of polysemous words.

The results of the norming study revealed that the number of senses listed by the participants was much larger than the number of senses listed in the dictionary. However, after categorizing the senses listed by the participants according to the dictionary, the direction of this difference changed. The number of dictionary senses was larger than the number of dictionary senses appearing in the participants' descriptions. This finding was in accordance with the results of the studies conducted in English and Chinese (Gernsbacher, 1984; Lin & Ahrens, 2005). However, the number of dictionary senses that were rated as familiar by the participants was larger than the number of dictionary senses listed by the participants. A similar tendency was observed with the raw senses listed by the participants – although they listed two or three senses on average, they were familiar with most of

the senses collected in the study. This finding was in accordance with the assumption that participants are not able to list all of the familiar senses in a short period of time (Azuma, 1996). In spite of the differences in the number of senses that was estimated with various techniques, a positive correlation was observed among all of the collected measures. As expected, we observed a high correlation between sense frequencies and sense familiarity ratings. However, there were senses listed by a small number of participants only but at the same time rated as highly familiar.

The words selected for this study were generally rated by the participants as very familiar and mostly concrete. However, we noticed that word familiarity and word concreteness were related to the familiarity/concreteness of the dominant sense. This finding pointed to the fact that during the process of making a judgment on certain aspects of the whole word, participants were mostly relying on the dominant sense. In addition to this, we observed that concrete senses were more frequently listed,and were rated as more familiar.

Future research will be aiming at examining the relation among the collected measures in more detail. We believe that an understanding of the nature of these relations would contribute to understanding the way word senses are represented and processed. On the other hand, in further research we will explore the way entropy affects the processing of polysemous words. We will be particularly interested in the effects of the balance of sense probabilities.

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Appendix 1

Table of familiarity (left) and concreteness (right) ratings of a word, ratings averaged across individual senses listed in the dictionary *Rečnik Matice srpske* and ratings averaged across senses listed by the participants.

	Familiarity			**Concreteness**		
	word	**mean senses, dictionary**	**mean senses, participants**	**word**	**mean senses, dictionary**	**mean senses, participants**
album	6.56 (0.62)	5.98 (1.07)	5.41 (1.66)	6.52 (0.9)	6.2 (0.73)	6.35 (0.94)
balkon	6.19 (1.17)	4.77 (0.39)	6.48 (0.59)	6.95 (0.22)	6.48 (0.07)	5.79 (1.04)
balon	6.84 (0.37)	5.09 (0.49)	5.1 (0.84)	6.65 (0.57)	6.03 (1.1)	5.71 (1.44)
berba	5.67 (1.28)	5.76 (1.17)	4.55 (1.39)	5.29 (1.68)	3.71 (1.5)	5.02 (1.35)
blok	6.56 (0.7)	5.54 (0.66)	5.1 (1.81)	5.52 (1.47)	5.19 (1.35)	5.28 (1.54)
boks	5.82 (1.29)	4.85 (2.13)	4.67 (0.21)	5.7 (1.06)	5.37 (0.74)	5.25 (1.47)
brada	6.56 (0.86)	4.78 (0.58)	4.9 (0.29)	6.7 (0.56)	5.83 (1)	4.68 (1.64)
ćelija	6 (1.25)	5.47 (0.21)	4.2 (2.02)	4.24 (1.92)	5.31 (1.26)	4.23 (1.74)
centar	6.82 (0.53)	5.46 (1.26)	5.17 (1.48)	3.7 (1.33)	3.97 (1.37)	4.05 (1.89)
ciklus	5.59 (0.94)	5.24 (1.21)	6.74 (0.88)	1.96 (1.19)	4 (0.07)	3.8 (1.79)
članak	6.11 (1.05)	5.32 (1.09)	4.47 (0.67)	5.87 (1.25)	5.52 (0.87)	5.91 (1.13)
crevo	6.63 (0.68)	5.27 (0.29)	5.37 (0.2)	6.39 (0.89)	5.1 (1.69)	5.35 (1.53)
čvor	6.5 (0.71)	4.93 (1.76)	4.07 (0.22)	5.78 (1.04)	4.41 (2.2)	4.55 (1.58)
đavo	6.42 (0.84)	5.4 (1.26)	5.34 (1.37)	2.43 (1.66)	2.47 (0.64)	3.42 (2.19)
dinar	6.89 (0.32)	5.28 (0.24)	6.93 (0.21)	6.38 (0.92)	5.25 (0.07)	4.49 (1.92)

	Familiarity			Concreteness		
	word	**mean senses, dictionary**	**mean senses, participants**	**word**	**mean senses, dictionary**	**mean senses, participants**
disk	6.42 (0.84)	5.17 (0.61)	4.09 (1.15)	6.43 (0.84)	5.76 (0.8)	5.75 (1.53)
doktor	6.72 (0.67)	5.41 (0)	6.67 (1.07)	5.96 (1.15)	5.15 (1.63)	4.03 (1.51)
dugme	6.53 (0.84)	5.15 (1.45)	4.94 (0)	6.96 (0.21)	5.84 (1.24)	5.08 (1.51)
dvojka	6.71 (0.85)	4.62 (0.5)	3.17 (1.28)	4.04 (2.06)	5.07 (0.54)	4.48 (1.71)
figura	6.33 (0.84)	5.89 (1.26)	5.15 (1.35)	5.57 (1.63)	4.85 (1.45)	4.99 (1.53)
forma	6 (1.05)	5.36 (1.33)	5.1 (1)	2.65 (1.53)	4.04 (1.73)	4.33 (1.56)
gluma	6.47 (0.8)	6.26 (1.63)	5.86 (0.56)	2.57 (1.2)	4.46 (0.64)	4.14 (1.86)
govor	6.74 (0.56)	5.6 (1.27)	5.47 (0.93)	4.33 (1.83)	4.87 (0.78)	4.32 (1.63)
građa	6.06 (1.25)	5.05 (1.54)	5.46 (0.93)	4.13 (1.6)	5.17 (1.02)	4.01 (1.57)
grudi	6.42 (0.77)	4.93 (1.69)	5.5 (0.78)	6.48 (0.9)	5.15 (1.83)	4.35 (1.16)
grupa	6.47 (0.62)	5.37 (1.07)	5.61 (0.43)	4.96 (1.89)	4.2 (1.31)	4.52 (1.84)
guma	6.58 (0.9)	5.15 (1.52)	6.17 (1.81)	6.76 (0.54)	6.29 (0.82)	5.8 (1.59)
igrač	6.41 (1.18)	5.23 (0.96)	4.84 (0.49)	6.3 (1.15)	6 (0.8)	5.14 (1.32)
izbor	6.56 (0.63)	5.93 (0.81)	6.68 (0.72)	2.29 (1.49)	3.38 (0.32)	3.76 (1.74)
izlet	6.06 (1.09)	4.98 (0.33)	4.92 (0)	4.13 (1.52)	4.24 (0.54)	4.69 (1.61)
izraz	6.25 (1)	5.91 (0.48)	6.3 (0.78)	2.3 (1.18)	4.81 (0.91)	4.65 (1.93)
izvor	6.31 (1.3)	5.55 (0.79)	5.57 (0.64)	5.04 (1.3)	3.97 (1.48)	4.35 (1.9)
jezik	6.88 (0.34)	5.67 (0)	4.22 (0.64)	5.24 (1.79)	4.01 (1.4)	4.56 (1.86)
kanal	6.06 (1.25)	5.53 (1.69)	6.32 (0.69)	5.22 (1.57)	5.54 (2.07)	4.82 (1.62)

	Familiarity			Concreteness		
	word	**mean senses, dictionary**	**mean senses, participants**	**word**	**mean senses, dictionary**	**mean senses, participants**
kapak	6.24 (1.03)	3.78 (0)	3.37 (1.56)	6.3 (1.06)	5.62 (0.84)	5.33 (1.17)
ključ	6.83 (0.38)	5 (0)	3.75 (0)	6.57 (0.93)	4.32 (1.37)	4.1 (1.22)
kljun	5.88 (1.54)	3.98 (0.23)	3.74 (0)	6.74 (0.69)	5.19 (1.02)	5.54 (1.36)
klub	6.68 (0.58)	5.63 (1.11)	6.64 (0.87)	4.91 (1.7)	4.76 (1.82)	4.9 (1.59)
klupa	6.59 (0.71)	5.01 (1.43)	3.73 (1.29)	6.81 (0.51)	5.35 (1.2)	5.19 (1.31)
kolač	6.89 (0.32)	5.48 (0)	3.56 (1.24)	6.91 (0.29)	5.49 (1.21)	5.44 (1.25)
komad	6.47 (0.62)	5.75 (1.17)	6.1 (1.12)	5.26 (1.63)	5.35 (0.99)	5.75 (1.59)
komora	5.29 (1.76)	4.46 (1.12)	3.42 (1.4)	4.9 (1.64)	4.52 (1.23)	5.03 (1.56)
korak	6.65 (0.86)	5.6 (1.38)	5.76 (0)	5.48 (1.03)	4.12 (1.77)	3.62 (1.25)
koren	6.32 (0.89)	5.39 (0.53)	5.54 (0)	5.57 (1.47)	4.44 (1.59)	3.77 (1.68)
korica	6.28 (1.13)	4.51 (0.7)	5.06 (1.25)	6.57 (0.51)	5.44 (1.21)	5.83 (1.48)
koža	6.84 (0.5)	5.44 (0.46)	5.7 (0)	6.81 (0.51)	5.28 (1.97)	5.3 (1.23)
krug	6.82 (0.53)	5.14 (0.87)	5.34 (0.59)	4.65 (1.77)	4.38 (1.28)	4.49 (1.85)
kruna	6.31 (0.95)	5.16 (1.59)	4.58 (0.43)	6.43 (0.79)	4.85 (1.3)	4.91 (1.71)
krzno	6.32 (1.11)	5.36 (1.97)	6.38 (0.29)	6.81 (0.4)	6.48 (0.53)	5.34 (1.24)
kurs	6 (1.19)	5.74 (0.9)	5.69 (1.89)	2.57 (1.57)	3.41 (0.79)	3.44 (1.83)
lanac	6.63 (0.68)	5.6 (0.71)	4.44 (0.34)	6.22 (1.17)	4.23 (1.28)	4.49 (1.52)
linija	6.74 (0.65)	5.1 (1.91)	5.28 (0.63)	4.81 (1.47)	4 (1.53)	4.15 (1.38)
list	6.65 (0.79)	5.39 (0.42)	4.76 (0)	6.65 (0.65)	5.64 (0.74)	5.43 (1.14)

	Familiarity			Concreteness		
	word	**mean senses, dictionary**	**mean senses, participants**	**word**	**mean senses, dictionary**	**mean senses, participants**
lopta	6.79 (0.54)	5.04 (1.6)	6.05 (0.85)	6.57 (1.08)	5.82 (0.79)	4.94 (1.51)
loza	6 (1.29)	4.79 (1.12)	4.72 (0.34)	4.57 (1.75)	5.03 (1.61)	4.58 (1.29)
marka	6.63 (0.6)	5.3 (0.84)	4.75 (0.69)	5.26 (1.66)	4.49 (1.73)	4.62 (1.45)
masa	6.12 (1.17)	5.45 (1.02)	5.39 (0.42)	3.9 (1.79)	4.74 (1.27)	4.74 (1.5)
matica	5 (1.6)	4.51 (1.79)	4.62 (0.78)	4.43 (1.63)	4.77 (0.99)	4.98 (1.91)
mehur	5.67 (1.33)	4.44 (1.83)	4.71 (1.72)	6.05 (1.36)	5.63 (0.36)	5.38 (1.88)
mera	5.72 (1.32)	5.6 (1.95)	5.03 (1.14)	2.83 (1.7)	3.12 (0.98)	3.72 (1.69)
metar	6.53 (0.74)	5.22 (0)	5.38 (0.64)	4.57 (2.2)	3.95 (1.57)	4.5 (1.55)
minut	6.79 (0.54)	6.14 (0.39)	6.5 (0.29)	2.57 (1.5)	4.02 (1.09)	4.02 (2.11)
miris	6.44 (1.29)	5.85 (0.24)	6.46 (0.34)	4.76 (1.67)	5.28 (2.17)	4.61 (1.43)
model	6.44 (0.78)	5.97 (0.96)	5.63 (0.72)	4.71 (1.31)	5.43 (1.25)	5.43 (1.33)
momak	6.82 (0.73)	5.44 (0.24)	5.24 (0.29)	6.43 (0.98)	5.45 (0.7)	5.73 (1.36)
most	6.71 (0.77)	5.06 (0.24)	5.24 (1.04)	6.22 (1.28)	4.87 (1.78)	4.58 (1.78)
motiv	6.26 (0.99)	6.2 (0.33)	6.41 (0.29)	1.57 (1.21)	4.43 (1.83)	4.03 (2.05)
mreža	6.47 (1.07)	5.44 (1.15)	5.83 (0.66)	5.81 (1.54)	4.91 (1.67)	4.76 (1.65)
obim	6 (1.12)	5.56 (1.04)	6.24 (0.42)	3.6 (2.09)	3.83 (1.52)	4.65 (1.55)
oblast	5.82 (1.47)	5.45 (0.56)	5.2 (0.53)	3.7 (1.38)	4 (1.48)	4.7 (1.81)
oblik	6.18 (1.29)	5.71 (0.58)	5.26 (1.11)	4.05 (1.83)	4.45 (1.07)	4.48 (1.8)
obrada	6.05 (1.13)	5.61 (1.51)	5.98 (1.79)	2.67 (1.43)	4.13 (0.98)	4.65 (1.72)

	Familiarity			Concreteness		
	word	**mean senses, dictionary**	**mean senses, participants**	**word**	**mean senses, dictionary**	**mean senses, participants**
obruč	5.24 (1.35)	4.86 (1.49)	4.54 (1.59)	6.13 (1.01)	3.96 (1.7)	4.89 (1.53)
ocena	6.78 (0.43)	6.11 (1.15)	6.39 (0.85)	4 (1.83)	4.05 (1.36)	3.42 (1.99)
oklop	5.75 (1.77)	5.28 (0.97)	5.75 (0.29)	6.52 (0.98)	5.29 (1.61)	5.8 (1.31)
organ	6.53 (0.51)	6 (0.24)	4.58 (0.21)	5.38 (1.63)	4.6 (1.06)	4.05 (1.73)
osnova	6.22 (0.94)	5.23 (1.21)	5.28 (1.4)	2.81 (1.25)	4 (1.17)	3.94 (1.61)
patent	4.94 (1.69)	5.12 (1.21)	4.91 (1.35)	4.29 (1.74)	4.48 (0.95)	5.35 (1.35)
pesak	6.29 (0.92)	5.49 (0.64)	6.15 (1.85)	6.65 (0.57)	6.43 (0.53)	6.13 (1.03)
pešak	6.65 (0.7)	4.84 (1.59)	5.57 (0)	6.61 (0.78)	6.38 (0.19)	5.69 (1.2)
pisak	3.71 (1.69)	4.71 (1.7)	3.43 (2.1)	5.19 (1.63)	5.8 (0.49)	6.1 (0.99)
pismo	6.71 (0.77)	5.85 (1.33)	4.84 (0.7)	6.48 (1.24)	4.96 (0.97)	5.51 (1.67)
platno	6.39 (0.85)	5.27 (0.29)	4.17 (1.49)	6.33 (0.8)	5.48 (1.48)	5.57 (1.59)
ploča	6.53 (0.77)	5.49 (0.8)	4.18 (1.07)	6.48 (0.85)	5.21 (0.88)	5.87 (1.29)
plod	6.29 (1.05)	6.05 (1.01)	6.42 (0.22)	6.29 (1.06)	5.03 (2.36)	5.42 (1.18)
pojas	6.35 (1.17)	5.33 (1.37)	4.04 (1.58)	5.86 (1.35)	4.17 (1.52)	5.23 (1.54)
pojava	6.33 (0.91)	5.93 (1.09)	4.83 (1.98)	2.52 (1.44)	3.72 (1.44)	4.74 (1.75)
pokret	6.53 (0.87)	5.74 (1)	5.06 (1.05)	4.39 (1.78)	4.36 (1.87)	4.36 (1.62)
polet	5.28 (1.18)	4.05 (1.42)	5.68 (2.08)	1.83 (1.37)	3.44 (1.26)	3.52 (1.85)
posao	6.88 (0.33)	5.89 (1.18)	5.66 (0.53)	3.48 (1.75)	3.87 (0.62)	3.84 (1.94)
poskok	5.67 (1.37)	4.06 (0)	6.19 (1.92)	6.48 (0.98)	6.24 (1.01)	5.84 (0.82)

	Familiarity			Concreteness		
	word	**mean senses, dictionary**	**mean senses, participants**	**word**	**mean senses, dictionary**	**mean senses, participants**
pošta	6.81 (0.4)	5.64 (0.43)	4.42 (1.86)	5.86 (1.15)	4.73 (1.62)	5.03 (1.51)
potez	5.67 (1.46)	5.53 (1.28)	4.75 (2.03)	3.3 (1.58)	4.13 (0.94)	4.56 (1.82)
poziv	6.37 (0.9)	5.78 (0.31)	5.61 (0.71)	3.57 (1.95)	4.22 (1.67)	4.16 (1.79)
prašak	6.33 (0.84)	5.1 (0.64)	3.95 (1.14)	6.48 (0.73)	4.13 (1.55)	5.98 (1.06)
pravac	6.67 (0.59)	5.27 (0.31)	4.97 (1.43)	2.57 (1.31)	3.61 (1.34)	3.43 (1.83)
prenos	6.06 (1.2)	5.55 (1.02)	5.78 (0.8)	2.7 (1.33)	4.51 (1.16)	3.93 (2.01)
prilog	6.18 (1.13)	6.49 (0.73)	6.03 (1.13)	3.48 (1.75)	4.86 (0.73)	4.43 (1.54)
profil	6.21 (1.03)	4.7 (0)	5.11 (0.28)	4.91 (1.65)	4.73 (1.17)	3.88 (1.72)
pruga	6.22 (1.35)	5.09 (0.66)	3.74 (0.39)	6.67 (0.73)	4.72 (1.38)	5.64 (1.14)
račun	6.71 (0.47)	5.98 (1.09)	4.91 (1.77)	5.7 (1.26)	3.67 (1.2)	3.58 (1.69)
radnja	6.67 (0.49)	5.95 (0.75)	4.5 (0.95)	3.52 (1.9)	4.77 (1.03)	4.58 (1.5)
rebro	6.12 (1.36)	4.93 (0.49)	3.39 (0)	6.57 (1.16)	5.3 (0.53)	5.89 (0.9)
salon	6.32 (1.16)	5.53 (0.86)	5.53 (1.32)	6.1 (0.83)	5.49 (1.38)	6.42 (0.83)
samica	5.67 (1.33)	4.96 (0.75)	4.67 (1.92)	4.91 (1.68)	5.88 (0.89)	5.49 (1.38)
sastav	6.18 (1.13)	5.53 (0.5)	5.49 (0.9)	3.57 (1.85)	4.52 (1.04)	4.66 (1.87)
savet	6.63 (0.68)	5.85 (0.21)	5.43 (0)	2.48 (1.72)	4.08 (0.38)	4.02 (1.75)
scena	6.26 (0.93)	5.75 (1.34)	6.45 (0.58)	4.33 (1.68)	5.19 (0.84)	4.69 (1.62)
servis	5.59 (1.62)	6.04 (1.66)	5.64 (1.85)	4.95 (1.66)	5.31 (1.18)	5.06 (1.69)
sfera	4.89 (1.64)	4.92 (1.89)	5.66 (1.33)	3.29 (1.71)	4.03 (1.39)	3.71 (1.82)

	Familiarity			Concreteness		
	word	**mean senses, dictionary**	**mean senses, participants**	**word**	**mean senses, dictionary**	**mean senses, participants**
signal	5.59 (1.42)	5.85 (0.84)	5.65 (1)	4.14 (1.59)	4.35 (1.78)	5.34 (1.6)
sila	6.53 (0.72)	5.65 (1.53)	5.16 (1.02)	2.26 (1.39)	3.59 (0.74)	3.3 (1.84)
sistem	6.42 (0.84)	5.41 (1.5)	4.94 (1.93)	2.35 (1.23)	3.62 (1.25)	3.7 (1.97)
skakač	5.95 (1.08)	5.56 (0.58)	5 (1.95)	5.87 (0.97)	6.19 (0.38)	6.56 (0.83)
skok	6.5 (0.82)	5.25 (1.99)	5.08 (0.94)	4.67 (1.62)	3.99 (1.67)	4.65 (1.24)
škola	6.95 (0.23)	5.72 (1.19)	5.78 (1.33)	6.1 (0.94)	4.32 (1.12)	3.67 (1.84)
sloj	5.74 (1.33)	5.34 (1.61)	6.65 (0.73)	4.09 (1.7)	4.78 (2.37)	4.54 (1.35)
sluh	6.47 (1.07)	5.79 (0.21)	5.5 (0)	3.05 (1.77)	3.43 (1.2)	3.51 (2.03)
smer	5.83 (1.15)	6.05 (1.09)	4.97 (0.69)	3.43 (1.89)	3.02 (1.25)	4.06 (1.8)
snimak	6.12 (1.27)	5.33 (1.36)	5.62 (0.8)	5.52 (1.36)	5.53 (1.45)	5.84 (1.06)
stav	6.5 (0.62)	5.74 (1.33)	5.14 (0.77)	1.52 (0.85)	3.93 (1.12)	4.36 (1.57)
stena	6 (1.14)	4.79 (0.99)	4.14 (1.1)	6.81 (0.4)	4.92 (2.06)	3.72 (1.55)
stepen	5.94 (1.26)	5.92 (1.09)	5.21 (0.9)	2.35 (1.72)	3.64 (0.91)	3.3 (1.97)
stopa	5.94 (1.11)	4.85 (1.96)	4.21 (1.56)	4.52 (1.9)	4.41 (1.22)	4.56 (1.59)
struja	6.44 (1.15)	5.38 (0.22)	5.1 (1.35)	4.86 (1.65)	4.13 (1.1)	3.34 (1.86)
struk	6.22 (1)	5.03 (1.86)	4 (1.82)	6.04 (1.19)	5.34 (0.65)	5.8 (1.23)
tabla	6.82 (0.39)	5.22 (0.29)	4.3 (1.43)	6.78 (0.52)	5.2 (1.46)	5.56 (1.32)
tačka	6.82 (0.73)	5.64 (0.58)	5.39 (1.62)	4.57 (2.01)	4.2 (1.22)	4.14 (1.84)
talas	6.47 (0.7)	5.6 (0.29)	5.54 (0)	5.43 (1.63)	4.83 (1.41)	4.65 (1.7)

	Familiarity			Concreteness		
	word	**mean senses, dictionary**	**mean senses, participants**	**word**	**mean senses, dictionary**	**mean senses, participants**
tekst	6.65 (0.7)	6.32 (0.47)	5.79 (0.22)	6.1 (1.3)	5.86 (0.37)	4.92 (1.41)
termin	6 (1.46)	6.16 (0.96)	5.63 (0.37)	2.57 (1.75)	3.49 (0.73)	3.56 (1.91)
teza	4.71 (1.76)	5.69 (1.46)	4.59 (1.28)	1.96 (1.46)	3.71 (1.02)	3.66 (1.6)
tezga	6.16 (1.12)	6.03 (0)	6.5 (0.31)	6.38 (0.97)	4.88 (2.65)	4.6 (1.38)
traka	6.63 (0.68)	5.2 (1.07)	4.39 (0.47)	6.29 (0.72)	5.18 (1.71)	6.09 (1.06)
ugao	6.13 (1.26)	6.01 (0.74)	5.95 (0.61)	4.39 (1.41)	5.23 (1.43)	5.17 (1.58)
ukus	6.63 (0.83)	6.02 (1.05)	6.57 (1.05)	4.09 (1.78)	4.45 (1.95)	3.58 (1.75)
uslov	5.84 (1.21)	5.96 (0.35)	6.83 (0.2)	2.05 (1.43)	3.39 (0.06)	3.32 (1.93)
uspon	5.94 (1.39)	5.49 (0.53)	5.07 (0.93)	4.1 (1.92)	4.61 (1.12)	4.13 (1.69)
vatra	6.74 (0.56)	4.99 (0.82)	4.5 (0.49)	6.24 (0.94)	4.02 (1.38)	4.21 (1.39)
venac	5.94 (1.26)	5.15 (0.54)	4.15 (0.21)	6.39 (1.03)	4.87 (0.85)	4.87 (1.7)
veza	6.61 (0.5)	5.51 (1.12)	5.9 (1.97)	3.14 (1.31)	4.16 (1.07)	3.63 (1.43)
visina	6.71 (0.77)	5.56 (0)	5.69 (1.36)	4 (1.62)	4.11 (1)	4.47 (1.65)
vrat	6.44 (1.15)	4.74 (0)	6.11 (0)	7 (0)	6.43 (0.54)	5.13 (1.87)
vreća	6.39 (0.98)	4.54 (0.96)	4 (0.29)	6.52 (0.73)	4.11 (2.05)	4.9 (1.17)
zakon	6.32 (1.16)	5.65 (0.5)	5.01 (1)	3.05 (1.94)	2.81 (0.88)	3.01 (1.52)
zglob	6.35 (0.86)	4.33 (0.23)	3.16 (0)	6.52 (0.85)	4 (1.92)	5.66 (1.4)
žica	6.33 (0.97)	5.17 (1.54)	3.98 (1.78)	6.62 (0.67)	4.38 (1.75)	5.05 (1.17)
znak	6.28 (0.83)	5.61 (1.15)	5.67 (1.92)	4.76 (1.87)	5.01 (0.95)	4.42 (1.63)

	Familiarity			Concreteness		
	word	**mean senses, dictionary**	**mean senses, participants**	**word**	**mean senses, dictionary**	**mean senses, participants**
zrno	6.56 (0.62)	5.51 (0.44)	5.47 (0.43)	6.3 (0.88)	6.1 (0.62)	5.39 (1.56)
zvono	6.61 (0.85)	4.78 (1.43)	5.25 (0.21)	6.7 (1.06)	4.75 (1.86)	5.2 (1.18)

Appendix 2

Table of number of senses (N), entropy (H) and redundancy (T) of sense probability distribution based on the senses a) listed by the participants, b) listed by more than 10% of the participants, c) with a mean familiarity rating of 2 or higher, d) with a mode familiarity rating above 1, and e) with a median familiarity rating above 1.

	a) Senses listed by participants			**b) Senses listed by more than 10% of participants**			**c) Senses with mean familiarity rating>1.9**			**d) Senses with mode familiarity rating >1**			**e) Senses with median familiarity rating >1**		
	N	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
album	5	2.12	0.09	5	2.12	0.09	5	2.12	0.09	5	2.12	0.09	5	2.12	0.09
balkon	6	1.81	0.30	4	1.5	0.25	5	1.57	0.33	5	1.57	0.33	5	1.57	0.33
balon	12	3.13	0.13	10	3	0.1	12	3.13	0.13	10	2.94	0.12	12	3.13	0.13
berba	8	2.76	0.08	6	2.46	0.05	8	2.76	0.08	7	2.61	0.07	8	2.76	0.08
blok	16	3.54	0.11	14	3.43	0.1	16	3.54	0.11	16	3.54	0.11	16	3.54	0.11
boks	12	2.97	0.17	7	2.51	0.1	12	2.97	0.17	9	2.71	0.15	12	2.97	0.17
brada	7	2.00	0.29	5	1.77	0.24	7	2.00	0.29	5	1.70	0.27	7	2.00	0.29
ćelija	13	2.91	0.21	8	2.51	0.16	12	2.83	0.21	12	2.83	0.21	12	2.83	0.21
centar	18	3.70	0.11	11	3.29	0.05	17	3.65	0.11	17	3.65	0.11	17	3.65	0.11
ciklus	21	3.80	0.13	9	2.93	0.08	21	3.80	0.13	19	3.68	0.13	21	3.80	0.13
članak	8	2.12	0.29	5	1.79	0.23	9	2.01	0.36	9	2.01	0.36	9	2.01	0.36
crevo	11	2.51	0.27	6	2.05	0.21	12	2.51	0.30	12	2.51	0.30	12	2.51	0.3
čvor	17	3.53	0.14	10	2.96	0.11	16	3.46	0.13	16	3.46	0.13	16	3.46	0.13
đavo	25	4.19	0.10	12	3.42	0.05	25	4.14	0.11	23	4.09	0.10	24	4.14	0.1

	a) Senses listed by participants			b) Senses listed by more than 10% of participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
dinar	6	1.96	0.24	4	1.73	0.13	6	1.96	0.24	5	1.85	0.20	6	1.96	0.24
disk	13	3.06	0.17	9	2.74	0.14	13	3.06	0.17	10	2.73	0.18	13	3.06	0.17
doktor	4	1.60	0.20	3	1.46	0.08	4	1.60	0.20	4	1.60	0.20	4	1.60	0.2
dugme	6	2.24	0.13	6	2.24	0.13	6	2.24	0.13	5	2.02	0.13	6	2.24	0.13
dvojka	16	3.30	0.17	8	2.73	0.09	15	3.24	0.17	11	2.80	0.19	14	3.11	0.18
figura	14	3.39	0.11	11	3.22	0.07	14	3.39	0.11	14	3.39	0.11	14	3.39	0.11
forma	15	3.22	0.18	10	2.85	0.14	13	3.08	0.17	13	3.08	0.17	13	3.08	0.17
gluma	7	2.44	0.13	5	2.2	0.05	7	2.44	0.13	7	2.44	0.13	7	2.44	0.13
govor	17	3.39	0.17	9	2.84	0.11	17	3.33	0.19	17	3.33	0.19	17	3.33	0.19
građa	8	2.23	0.26	4	1.78	0.11	8	2.23	0.26	7	2.12	0.24	8	2.23	0.26
grudi	12	2.67	0.26	7	2.17	0.23	12	2.67	0.26	10	2.48	0.25	12	2.67	0.26
grupa	25	4.11	0.12	15	3.54	0.1	25	4.11	0.12	25	4.11	0.12	25	4.11	0.12
guma	15	3.18	0.19	11	2.96	0.14	15	3.18	0.19	15	3.18	0.19	15	3.18	0.19
igrač	10	2.61	0.22	6	2.21	0.14	10	2.61	0.22	10	2.61	0.22	10	2.61	0.22
izbor	16	3.58	0.10	8	2.89	0.04	16	3.58	0.10	16	3.58	0.10	16	3.58	0.1
izlet	11	2.97	0.14	8	2.65	0.12	11	2.97	0.14	11	2.97	0.14	11	2.97	0.14
izraz	10	3.10	0.07	10	3.1	0.07	10	3.10	0.07	10	3.10	0.07	10	3.10	0.07
izvor	10	2.85	0.14	7	2.57	0.09	10	2.85	0.14	10	2.85	0.14	10	2.85	0.14
jezik	16	3.24	0.19	8	2.61	0.13	16	3.24	0.19	14	3.09	0.19	15	3.17	0.19

	a) Senses listed by participants			**b) Senses listed by more than 10% of participants**			**c) Senses with mean familiarity rating>1.9**			**d) Senses with mode familiarity rating >1**			**e) Senses with median familiarity rating >1**		
	N	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
kanal	20	3.89	0.10	13	3.46	0.06	20	3.89	0.10	18	3.78	0.09	20	3.89	0.1
kapak	9	2.29	0.28	5	1.8	0.22	8	2.18	0.27	5	1.72	0.26	7	1.99	0.29
ključ	13	3.12	0.16	8	2.79	0.07	13	3.12	0.16	11	2.99	0.13	13	3.12	0.16
kljun	10	2.62	0.21	6	2.2	0.15	10	2.62	0.21	6	1.81	0.30	9	2.52	0.2
klub	13	3.04	0.18	8	2.66	0.11	13	3.04	0.18	13	3.04	0.18	13	3.04	0.18
klupa	11	2.68	0.22	5	2.06	0.11	10	2.59	0.22	10	2.59	0.22	10	2.59	0.22
kolač	9	2.71	0.14	7	2.5	0.11	9	2.71	0.14	8	2.49	0.17	9	2.71	0.14
komad	13	3.11	0.16	8	2.69	0.1	13	3.11	0.16	13	3.11	0.16	13	3.11	0.16
komora	20	3.67	0.15	7	2.63	0.06	20	3.67	0.15	17	3.42	0.16	20	3.67	0.15
korak	13	3.34	0.10	10	3.11	0.06	13	3.34	0.10	13	3.34	0.10	13	3.34	0.1
koren	16	3.39	0.15	12	3.17	0.12	16	3.39	0.15	15	3.33	0.15	16	3.39	0.15
korica	15	3.32	0.15	8	2.69	0.1	14	3.24	0.15	14	3.24	0.15	15	3.32	0.15
koža	15	3.13	0.20	7	2.47	0.12	15	3.13	0.20	14	3.06	0.20	15	3.13	0.2
krug	22	3.82	0.14	11	3.01	0.13	22	3.82	0.14	21	3.76	0.14	22	3.82	0.14
kruna	13	2.98	0.19	9	2.66	0.16	13	2.98	0.19	11	2.78	0.20	12	2.86	0.2
krzno	6	1.98	0.24	4	1.76	0.12	6	1.98	0.24	5	1.87	0.19	6	1.98	0.24
kurs	6	2.27	0.12	5	2.16	0.07	6	2.27	0.12	6	2.27	0.12	6	2.27	0.12
lanac	20	3.59	0.17	10	3.01	0.09	19	3.53	0.17	19	3.53	0.17	19	3.53	0.17
linija	34	4.48	0.12	14	3.61	0.05	35	4.48	0.13	34	4.45	0.13	35	4.48	0.13

	a) Senses listed by participants			b) Senses listed by more than 10% of participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
list	12	3.05	0.15	9	2.84	0.1	12	3.05	0.15	11	2.99	0.14	12	3.05	0.15
lopta	11	2.88	0.17	7	2.56	0.09	11	2.88	0.17	10	2.81	0.16	11	2.88	0.17
loza	10	2.61	0.21	7	2.36	0.16	8	2.40	0.20	8	2.40	0.20	8	2.40	0.2
marka	10	2.61	0.21	8	2.46	0.18	10	2.61	0.21	9	2.54	0.20	10	2.61	0.21
masa	11	3.01	0.13	8	2.79	0.07	11	3.01	0.13	11	3.01	0.13	11	3.01	0.13
matica	12	3.06	0.15	8	2.74	0.09	11	2.99	0.14	9	2.78	0.12	10	2.86	0.14
mehur	12	3.06	0.15	7	2.6	0.07	11	2.98	0.14	10	2.79	0.16	11	2.98	0.14
mera	14	3.29	0.14	10	2.96	0.11	14	3.29	0.14	14	3.29	0.14	14	3.29	0.14
metar	9	2.52	0.21	7	2.3	0.18	9	2.52	0.21	8	2.35	0.22	8	2.35	0.22
minut	8	2.60	0.13	6	2.4	0.07	8	2.60	0.13	8	2.60	0.13	8	2.60	0.13
miris	8	2.60	0.13	7	2.5	0.11	8	2.60	0.13	8	2.60	0.13	8	2.60	0.13
model	14	3.61	0.05	13	3.56	0.04	14	3.61	0.05	14	3.61	0.05	14	3.61	0.05
momak	6	1.89	0.27	3	1.48	0.06	6	1.89	0.27	6	1.89	0.27	6	1.89	0.27
most	15	3.17	0.19	7	2.5	0.11	15	3.17	0.19	14	3.09	0.19	15	3.17	0.19
motiv	10	2.98	0.10	9	2.9	0.09	10	2.98	0.10	10	2.98	0.10	10	2.98	0.1
mreža	25	4.10	0.12	16	3.64	0.09	25	4.10	0.12	25	4.10	0.12	25	4.10	0.12
obim	8	2.47	0.18	5	2.09	0.1	8	2.47	0.18	8	2.47	0.18	8	2.47	0.18
oblast	11	3.11	0.10	9	2.96	0.07	11	3.11	0.10	11	3.11	0.10	11	3.11	0.1
oblik	13	2.97	0.20	6	2.09	0.19	13	2.97	0.20	13	2.97	0.20	13	2.97	0.2

	a) Senses listed by participants			**b) Senses listed by more than 10% of participants**			**c) Senses with mean familiarity rating>1.9**			**d) Senses with mode familiarity rating >1**			**e) Senses with median familiarity rating >1**		
	N	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
obrada	14	3.29	0.14	10	3.01	0.09	14	3.29	0.14	14	3.29	0.14	14	3.29	0.14
obruč	14	3.19	0.16	8	2.7	0.1	14	3.19	0.16	13	3.11	0.16	14	3.19	0.16
ocena	6	2.31	0.11	6	2.31	0.11	6	2.31	0.11	6	2.31	0.11	6	2.31	0.11
oklop	9	2.74	0.14	7	2.53	0.1	9	2.74	0.14	9	2.74	0.14	9	2.74	0.14
organ	5	1.84	0.21	4	1.71	0.15	5	1.84	0.21	5	1.84	0.21	5	1.84	0.21
osnova	11	3.04	0.12	8	2.77	0.08	12	2.95	0.18	11	2.95	0.15	11	2.95	0.15
patent	7	2.35	0.16	5	2.06	0.11	6	2.21	0.15	6	2.21	0.15	6	2.21	0.15
pesak	11	3.13	0.10	7	2.69	0.04	11	3.13	0.10	9	2.85	0.10	11	3.13	0.1
pešak	7	2.18	0.22	4	1.84	0.08	7	2.18	0.22	5	1.96	0.16	6	2.07	0.2
pisak	12	3.26	0.09	9	2.97	0.06	11	3.17	0.08	9	2.89	0.09	11	3.17	0.08
pismo	8	2.37	0.21	4	1.94	0.03	8	2.37	0.21	8	2.37	0.21	8	2.37	0.21
platno	8	2.11	0.30	3	1.52	0.04	8	2.11	0.30	7	2.00	0.29	7	2.00	0.29
ploča	18	3.45	0.17	12	3.07	0.14	18	3.45	0.17	17	3.36	0.18	18	3.45	0.17
plod	10	2.87	0.14	7	2.59	0.08	10	2.87	0.14	10	2.87	0.14	10	2.87	0.14
pojas	19	3.70	0.13	11	3.19	0.08	17	3.58	0.12	16	3.52	0.12	17	3.58	0.12
pojava	16	3.63	0.09	13	3.43	0.07	16	3.63	0.09	16	3.63	0.09	16	3.63	0.09
pokret	20	3.81	0.12	9	2.99	0.06	20	3.81	0.12	20	3.81	0.12	20	3.81	0.12
polet	12	2.94	0.18	6	2.28	0.12	9	2.63	0.17	7	2.40	0.14	8	2.52	0.16
posao	9	2.84	0.11	7	2.66	0.05	9	2.84	0.11	8	2.75	0.08	9	2.84	0.11

	a) Senses listed by participants			b) Senses listed by more than 10% of participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
poskok	7	1.96	0.30	3	1.42	0.1	5	1.70	0.27	5	1.70	0.27	5	1.70	0.27
pošta	9	2.71	0.15	6	2.41	0.07	9	2.71	0.15	9	2.71	0.15	9	2.71	0.15
potez	11	2.88	0.17	7	2.53	0.1	10	2.80	0.16	9	2.57	0.19	10	2.80	0.16
poziv	13	3.18	0.14	9	2.89	0.09	12	3.11	0.13	12	3.11	0.13	12	3.11	0.13
prašak	11	3.08	0.11	7	2.75	0.02	12	3.08	0.14	9	2.83	0.11	12	3.08	0.14
pravac	18	3.57	0.14	12	3.19	0.11	18	3.57	0.14	16	3.45	0.14	18	3.57	0.14
prenos	14	3.04	0.20	7	2.46	0.12	14	3.04	0.20	14	3.04	0.20	14	3.04	0.2
prilog	8	2.54	0.15	7	2.44	0.13	8	2.54	0.15	8	2.54	0.15	8	2.54	0.15
profil	15	3.21	0.18	10	2.82	0.15	15	3.21	0.18	13	3.02	0.18	14	3.10	0.19
pruga	9	2.53	0.20	6	2.21	0.14	9	2.53	0.20	9	2.53	0.20	9	2.53	0.2
račun	14	3.30	0.13	11	3.11	0.1	14	3.30	0.13	14	3.30	0.13	14	3.30	0.13
radnja	8	2.28	0.24	7	2.19	0.22	8	2.28	0.24	8	2.28	0.24	8	2.28	0.24
rebro	8	2.34	0.22	7	2.23	0.2	8	2.34	0.22	6	1.89	0.27	8	2.34	0.22
salon	11	2.92	0.16	8	2.64	0.12	11	2.83	0.18	11	2.83	0.18	11	2.83	0.18
samica	9	2.37	0.25	4	1.7	0.15	9	2.37	0.25	8	2.14	0.29	9	2.37	0.25
sastav	12	3.08	0.14	8	2.78	0.07	12	3.08	0.14	10	2.93	0.12	11	3.01	0.13
savet	11	2.91	0.16	9	2.73	0.14	10	2.74	0.17	10	2.74	0.17	10	2.74	0.17
scena	19	3.33	0.22	7	2.48	0.12	16	3.14	0.21	16	3.14	0.21	16	3.14	0.21
servis	10	2.70	0.19	6	2.35	0.09	10	2.70	0.19	10	2.70	0.19	10	2.70	0.19

	a) Senses listed by participants			**b) Senses listed by more than 10% of participants**			**c) Senses with mean familiarity rating>1.9**			**d) Senses with mode familiarity rating >1**			**e) Senses with median familiarity rating >1**		
	N	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
sfera	11	2.78	0.20	7	2.41	0.14	11	2.78	0.20	8	2.46	0.18	11	2.78	0.2
signal	16	3.83	0.04	14	3.7	0.03	15	3.74	0.04	15	3.74	0.04	15	3.74	0.04
sila	24	4.04	0.12	11	3.27	0.05	24	4.04	0.12	23	3.99	0.12	23	3.99	0.12
sistem	25	4.10	0.12	12	3.37	0.06	24	4.05	0.12	24	4.05	0.12	24	4.05	0.12
skakač	9	2.51	0.21	5	2.04	0.12	9	2.51	0.21	9	2.51	0.21	9	2.51	0.21
skok	14	3.31	0.13	8	2.73	0.09	13	3.22	0.13	13	3.22	0.13	13	3.22	0.13
škola	14	3.11	0.18	7	2.51	0.11	14	3.11	0.18	13	3.03	0.18	14	3.11	0.18
sloj	12	3.08	0.14	9	2.83	0.11	11	2.96	0.15	11	2.96	0.15	11	2.96	0.15
sluh	6	1.95	0.24	5	1.84	0.21	6	1.95	0.24	6	1.95	0.24	6	1.95	0.24
smer	13	3.30	0.11	10	3.04	0.08	13	3.30	0.11	13	3.30	0.11	13	3.30	0.11
snimak	12	3.02	0.16	6	2.38	0.08	12	3.02	0.16	12	3.02	0.16	12	3.02	0.16
stav	12	2.64	0.26	6	2.04	0.21	12	2.64	0.26	12	2.64	0.26	12	2.64	0.26
stena	17	3.43	0.16	6	2.38	0.08	17	3.43	0.16	14	3.18	0.16	17	3.43	0.16
stepen	13	3.06	0.17	7	2.57	0.08	11	2.86	0.17	11	2.86	0.17	11	2.86	0.17
stopa	10	2.78	0.16	7	2.53	0.1	9	2.70	0.15	8	2.62	0.13	9	2.70	0.15
struja	10	2.75	0.17	8	2.56	0.15	10	2.75	0.17	9	2.66	0.16	10	2.75	0.17
struk	9	2.48	0.22	7	2.25	0.2	8	2.37	0.21	8	2.37	0.21	8	2.37	0.21
tabla	16	3.28	0.18	8	2.64	0.12	15	3.21	0.18	14	3.13	0.18	15	3.21	0.18
tačka	15	3.34	0.14	11	3.08	0.11	15	3.34	0.14	15	3.34	0.14	15	3.34	0.14

	a) Senses listed by participants			b) Senses listed by more than 10% of participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
talas	19	3.75	0.12	14	3.47	0.09	19	3.75	0.12	18	3.70	0.11	19	3.75	0.12
tekst	6	2.26	0.12	5	2.12	0.09	6	2.26	0.12	6	2.26	0.12	6	2.26	0.12
termin	6	2.21	0.14	6	2.21	0.14	6	2.21	0.14	6	2.21	0.14	6	2.21	0.14
teza	7	2.46	0.12	6	2.33	0.1	7	2.46	0.12	7	2.46	0.12	7	2.46	0.12
tezga	6	2.09	0.19	5	1.97	0.15	6	2.09	0.19	6	2.09	0.19	6	2.09	0.19
traka	25	4.21	0.09	17	3.85	0.06	25	4.21	0.09	23	4.12	0.09	25	4.21	0.09
ugao	8	2.69	0.10	7	2.6	0.07	8	2.69	0.10	7	2.60	0.07	8	2.69	0.1
ukus	11	2.93	0.15	7	2.57	0.08	10	2.84	0.14	10	2.84	0.14	10	2.84	0.14
uslov	11	2.97	0.14	8	2.66	0.11	11	2.97	0.14	11	2.97	0.14	11	2.97	0.14
uspon	8	2.35	0.22	5	2.01	0.13	8	2.35	0.22	6	2.13	0.18	8	2.35	0.22
vatra	19	3.84	0.10	11	3.36	0.03	18	3.78	0.09	18	3.78	0.09	18	3.78	0.09
venac	15	3.37	0.14	9	2.94	0.07	15	3.37	0.14	14	3.30	0.13	15	3.37	0.14
veza	23	3.86	0.15	14	3.37	0.11	23	3.86	0.15	22	3.81	0.15	23	3.86	0.15
visina	17	3.52	0.14	8	2.81	0.06	17	3.52	0.14	17	3.52	0.14	17	3.52	0.14
vrat	13	2.70	0.27	5	1.63	0.3	13	2.70	0.27	13	2.70	0.27	13	2.70	0.27
vreća	12	2.95	0.18	6	2.27	0.12	10	2.69	0.19	9	2.58	0.19	11	2.80	0.19
zakon	8	2.54	0.15	7	2.45	0.13	8	2.54	0.15	8	2.54	0.15	8	2.54	0.15
zglob	7	2.14	0.24	5	1.88	0.19	7	2.14	0.24	5	1.63	0.30	7	2.14	0.24
žica	15	3.56	0.09	12	3.37	0.06	15	3.56	0.09	14	3.43	0.10	15	3.56	0.09

	a) Senses listed by participants			**b) Senses listed by more than 10% of participants**			**c) Senses with mean familiarity rating>1.9**			**d) Senses with mode familiarity rating >1**			**e) Senses with median familiarity rating >1**		
	N	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
znak	13	3.33	0.10	12	3.26	0.09	14	3.33	0.13	14	3.33	0.13	14	3.33	0.13
zrno	10	3.03	0.09	8	2.87	0.04	10	3.03	0.09	10	3.03	0.09	10	3.03	0.09
zvono	20	3.81	0.12	14	3.49	0.08	18	3.71	0.11	16	3.54	0.12	17	3.66	0.11

Appendix 3

Table of a) the number of clusters of related senses (N1) and number of senses (N2) listed in the dictionary *Rečnik Matice srpske*; the number of dictionary senses (N), entropy (H) and redundancy (T) of the sense probability distribution, for the dictionary senses; b) listed by the participants, c) with a mean familiarity rating of 2 or higher, d) with a mode familiarity rating above 1, and e) with a median familiarity rating above 1.

	a) Senses listed in the dictionary		**b) Senses listed by participants**			**c) Senses with mean familiarity rating>1.9**			**d) Senses with mode familiarity rating >1**			**e) Senses with median familiarity rating >1**		
	N1	**N2**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
album	1	3	1	0.00	1.00	3	0.00	1.00	3	0.00	1.00	3	0.00	1
balkon	2	2	2	0.96	0.04	2	0.96	0.04	2	0.96	0.04	2	0.96	0.04
balon	4	6	4	1.90	0.05	5	1.90	0.18	4	1.90	0.05	5	1.90	0.18
berba	3	7	5	1.55	0.33	7	1.55	0.45	4	1.36	0.32	7	1.55	0.45
blok	7	7	5	2.18	0.06	6	2.18	0.16	5	2.18	0.06	6	2.18	0.16
boks	2	3	2	0.89	0.11	2	0.89	0.11	2	0.89	0.11	2	0.89	0.11
brada	4	5	4	1.64	0.18	5	1.64	0.29	3	1.31	0.17	5	1.64	0.29
ćelija	4	7	5	1.71	0.26	6	1.59	0.39	5	1.59	0.32	5	1.59	0.32
centar	8	9	7	2.40	0.15	9	2.40	0.24	8	2.40	0.20	9	2.40	0.24
ciklus	2	2	2	0.94	0.06	2	0.94	0.06	2	0.94	0.06	2	0.94	0.06
članak	5	7	5	1.87	0.19	6	1.87	0.28	4	1.25	0.38	6	1.87	0.28
crevo	3	3	2	1.00	0.00	3	1.00	0.37	2	1.00	0.00	3	1.00	0.37
čvor	8	11	7	2.35	0.16	10	2.35	0.29	9	2.35	0.26	10	2.35	0.29
đavo	4	12	8	2.36	0.21	12	2.36	0.34	12	2.36	0.34	12	2.36	0.34

	a) Senses listed in the dictionary		b) Senses listed by participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N1	**N2**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
dinar	2	2	2	0.99	0.01	2	0.99	0.01	2	0.99	0.01	2	0.99	0.01
disk	2	7	3	1.42	0.10	6	1.42	0.45	5	1.42	0.39	5	1.42	0.39
doktor	2	2	2	1.00	0.00	2	1.00	0.00	2	1.00	0.00	2	1.00	0
dugme	3	3	2	0.99	0.01	2	0.99	0.01	2	0.99	0.01	2	0.99	0.01
dvojka	6	9	2	0.89	0.11	5	0.89	0.62	3	0.89	0.44	5	0.89	0.62
figura	7	10	7	2.49	0.11	10	2.49	0.25	9	2.49	0.22	9	2.49	0.22
forma	6	6	5	1.95	0.16	6	1.95	0.24	6	1.95	0.24	6	1.95	0.24
gluma	3	4	3	1.58	0.00	4	1.58	0.21	4	1.58	0.21	4	1.58	0.21
govor	4	9	7	2.29	0.19	9	2.29	0.28	9	2.29	0.28	9	2.29	0.28
građa	6	7	5	1.90	0.18	7	1.90	0.32	6	1.90	0.27	7	1.90	0.32
grudi	4	4	2	1.00	0.00	4	1.00	0.50	4	1.00	0.50	4	1.00	0.5
grupa	3	5	4	1.80	0.10	5	1.80	0.23	5	1.80	0.23	5	1.80	0.23
guma	3	3	3	1.58	0.00	3	1.58	0.00	3	1.58	0.00	3	1.58	0
igrač	4	5	2	1.00	0.00	4	1.00	0.50	3	1.00	0.37	4	1.00	0.5
izbor	4	4	4	1.75	0.12	4	1.75	0.12	4	1.75	0.12	4	1.75	0.12
izlet	2	3	2	0.49	0.51	3	0.49	0.69	2	0.00	1.00	3	0.49	0.69
izraz	4	4	4	1.91	0.05	4	1.91	0.05	4	1.91	0.05	4	1.91	0.05
izvor	4	6	4	1.77	0.12	6	1.77	0.32	6	1.77	0.32	6	1.77	0.32
jezik	6	13	6	1.88	0.27	10	1.68	0.49	8	1.68	0.44	10	1.68	0.49

	a) Senses listed in the dictionary		b) Senses listed by participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N1	**N2**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
kanal	3	4	4	1.83	0.09	4	1.83	0.09	4	1.83	0.09	4	1.83	0.09
kapak	3	6	3	1.55	0.02	3	1.55	0.02	3	1.55	0.02	3	1.55	0.02
ključ	2	18	9	2.81	0.11	12	2.81	0.21	10	2.65	0.20	12	2.81	0.21
kljun	6	7	3	1.51	0.05	7	1.51	0.46	3	0.94	0.41	7	1.51	0.46
klub	1	2	2	1.00	0.00	2	1.00	0.00	2	1.00	0.00	2	1.00	0
klupa	5	6	3	1.16	0.27	3	0.99	0.37	3	0.99	0.37	3	0.99	0.37
kolač	6	9	3	1.08	0.32	5	1.08	0.54	4	1.08	0.46	4	1.08	0.46
komad	3	5	5	2.09	0.10	5	2.09	0.10	5	2.09	0.10	5	2.09	0.1
komora	5	9	5	1.97	0.15	7	1.84	0.34	4	1.51	0.24	8	1.84	0.39
korak	5	5	4	1.77	0.12	5	1.77	0.24	5	1.77	0.24	5	1.77	0.24
koren	6	9	7	2.54	0.10	9	2.54	0.20	8	2.54	0.15	9	2.54	0.2
korica	4	4	2	0.99	0.01	3	0.99	0.37	3	0.99	0.37	3	0.99	0.37
koža	3	4	4	1.45	0.27	4	1.45	0.27	3	1.24	0.22	4	1.45	0.27
krug	8	12	7	2.21	0.21	12	2.21	0.38	11	2.21	0.36	11	2.21	0.36
kruna	9	13	9	2.62	0.17	12	2.62	0.27	11	2.62	0.24	12	2.62	0.27
krzno	4	4	4	1.76	0.12	4	1.76	0.12	4	1.76	0.12	4	1.76	0.12
kurs	3	5	4	1.99	0.00	5	1.99	0.14	4	1.58	0.21	5	1.99	0.14
lanac	4	8	4	1.49	0.25	6	1.49	0.42	5	1.49	0.36	6	1.49	0.42
linija	9	13	10	2.79	0.16	12	2.70	0.25	12	2.70	0.25	13	2.79	0.25

	a) Senses listed in the dictionary		b) Senses listed by participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N1	**N2**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
list	8	10	5	2.05	0.12	10	2.05	0.38	8	2.05	0.32	9	2.05	0.35
lopta	4	5	4	1.87	0.06	5	1.87	0.19	5	1.87	0.19	5	1.87	0.19
loza	3	6	5	1.67	0.28	5	1.46	0.37	4	1.15	0.42	5	1.46	0.37
marka	4	5	3	1.56	0.02	3	1.56	0.02	3	1.56	0.02	3	1.56	0.02
masa	5	10	7	2.44	0.13	9	2.44	0.23	8	2.44	0.19	9	2.44	0.23
matica	9	11	8	2.77	0.08	11	2.77	0.20	10	2.77	0.17	10	2.77	0.17
mehur	4	7	6	2.15	0.17	7	2.15	0.23	6	1.81	0.30	7	2.15	0.23
mera	6	11	7	2.49	0.11	11	2.49	0.28	10	2.49	0.25	11	2.49	0.28
metar	6	6	3	1.17	0.26	6	1.17	0.55	5	1.17	0.50	6	1.17	0.55
minut	2	3	3	1.50	0.06	3	1.50	0.06	3	1.50	0.06	3	1.50	0.06
miris	3	3	3	1.47	0.07	3	1.47	0.07	3	1.47	0.07	3	1.47	0.07
model	5	8	6	2.34	0.09	8	2.34	0.22	8	2.34	0.22	8	2.34	0.22
momak	4	7	4	1.71	0.14	7	1.71	0.39	7	1.71	0.39	7	1.71	0.39
most	3	6	4	1.66	0.17	6	1.66	0.36	4	1.66	0.17	6	1.66	0.36
motiv	2	3	3	1.25	0.21	3	1.25	0.21	3	1.25	0.21	3	1.25	0.21
mreža	4	9	8	2.77	0.08	9	2.77	0.13	9	2.77	0.13	9	2.77	0.13
obim	2	2	2	1.00	0.00	2	1.00	0.00	2	1.00	0.00	2	1.00	0
oblast	5	7	3	1.57	0.01	6	1.57	0.39	6	1.57	0.39	6	1.57	0.39
oblik	9	11	8	2.31	0.23	11	2.31	0.33	10	2.31	0.31	10	2.31	0.31

	a) Senses listed in the dictionary		b) Senses listed by participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N1	**N2**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
obrada	4	4	4	1.75	0.13	4	1.75	0.13	4	1.75	0.13	4	1.75	0.13
obruč	6	8	5	2.19	0.06	8	2.19	0.27	8	2.19	0.27	8	2.19	0.27
ocena	0	4	3	1.55	0.02	4	1.55	0.22	4	1.55	0.22	4	1.55	0.22
oklop	4	4	3	1.54	0.03	4	1.54	0.23	4	1.54	0.23	4	1.54	0.23
organ	5	6	2	1.00	0.00	6	1.00	0.61	4	1.00	0.50	5	1.00	0.57
osnova	6	9	6	2.12	0.18	9	2.12	0.33	8	2.00	0.33	9	2.12	0.33
patent	4	6	4	1.54	0.23	6	1.54	0.40	5	1.54	0.34	6	1.54	0.4
pesak	2	2	2	0.63	0.37	2	0.63	0.37	2	0.63	0.37	2	0.63	0.37
pešak	3	3	3	1.39	0.12	3	1.39	0.12	3	1.39	0.12	3	1.39	0.12
pisak	4	10	5	2.19	0.06	7	2.19	0.22	5	2.19	0.06	7	2.19	0.22
pismo	4	8	4	1.69	0.16	8	1.69	0.44	6	1.53	0.41	8	1.69	0.44
platno	5	5	3	1.16	0.27	4	1.16	0.42	4	1.16	0.42	4	1.16	0.42
ploča	7	11	7	2.16	0.23	10	2.16	0.35	8	1.91	0.36	10	2.16	0.35
plod	3	3	3	1.57	0.01	3	1.57	0.01	3	1.57	0.01	3	1.57	0.01
pojas	9	14	6	2.30	0.11	13	2.30	0.38	10	2.30	0.31	13	2.30	0.38
pojava	6	7	4	1.86	0.07	7	1.86	0.34	7	1.86	0.34	7	1.86	0.34
pokret	4	7	5	2.26	0.03	7	2.26	0.20	7	2.26	0.20	7	2.26	0.2
polet	3	4	3	1.47	0.07	4	1.47	0.27	4	1.47	0.27	4	1.47	0.27
posao	4	9	5	1.91	0.18	9	1.91	0.40	9	1.91	0.40	9	1.91	0.4

	a) Senses listed in the dictionary		b) Senses listed by participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N1	**N2**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
poskok	2	2	2	1.00	0.00	2	1.00	0.00	2	1.00	0.00	2	1.00	0
pošta	5	8	4	1.80	0.10	7	1.80	0.36	4	1.80	0.10	6	1.80	0.3
potez	6	9	5	2.09	0.10	9	2.09	0.34	7	2.09	0.26	9	2.09	0.34
poziv	3	6	6	2.39	0.08	6	2.39	0.08	5	2.11	0.09	6	2.39	0.08
prašak	5	6	3	1.06	0.33	6	1.06	0.59	2	0.86	0.14	5	0.86	0.63
pravac	4	7	5	2.08	0.10	6	2.08	0.20	6	2.08	0.20	6	2.08	0.2
prenos	4	5	4	1.72	0.14	5	1.72	0.26	5	1.72	0.26	5	1.72	0.26
prilog	4	4	4	1.71	0.15	4	1.71	0.15	4	1.71	0.15	4	1.71	0.15
profil	5	5	3	1.36	0.14	5	1.36	0.41	5	1.36	0.41	5	1.36	0.41
pruga	7	12	4	1.61	0.19	11	1.61	0.53	9	1.39	0.56	12	1.61	0.55
račun	7	13	9	2.79	0.12	13	2.79	0.25	12	2.63	0.27	13	2.79	0.25
radnja	3	15	7	2.32	0.17	14	2.32	0.39	12	2.32	0.35	14	2.32	0.39
rebro	7	8	3	1.26	0.20	6	1.26	0.51	5	1.26	0.46	6	1.26	0.51
salon	3	5	5	2.09	0.10	5	2.09	0.10	5	2.09	0.10	5	2.09	0.1
samica	3	4	3	1.27	0.20	4	1.27	0.36	4	1.27	0.36	4	1.27	0.36
sastav	6	6	6	2.20	0.15	6	2.20	0.15	5	2.10	0.09	5	2.10	0.09
savet	5	6	5	1.89	0.19	6	1.89	0.27	6	1.89	0.27	6	1.89	0.27
scena	3	6	6	2.22	0.14	6	2.22	0.14	6	2.22	0.14	6	2.22	0.14
servis	3	4	4	1.80	0.10	4	1.80	0.10	4	1.80	0.10	4	1.80	0.1

	a) Senses listed in the dictionary		b) Senses listed by participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N1	**N2**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
sfera	4	5	4	1.75	0.12	5	1.75	0.24	5	1.75	0.24	5	1.75	0.24
signal	2	3	2	0.85	0.15	3	0.85	0.47	3	0.85	0.47	3	0.85	0.47
sila	12	18	11	3.06	0.12	18	3.06	0.27	17	3.06	0.25	18	3.06	0.27
sistem	8	12	10	2.85	0.14	12	2.85	0.20	12	2.85	0.20	12	2.85	0.2
skakač	3	4	3	1.58	0.01	4	1.58	0.21	4	1.58	0.21	4	1.58	0.21
skok	4	9	4	1.77	0.11	9	1.77	0.44	9	1.77	0.44	9	1.77	0.44
škola	4	7	4	1.58	0.21	7	1.58	0.44	7	1.58	0.44	7	1.58	0.44
sloj	2	2	2	0.97	0.03	2	0.97	0.03	2	0.97	0.03	2	0.97	0.03
sluh	4	4	3	1.25	0.21	4	1.25	0.37	3	1.25	0.21	3	1.25	0.21
smer	4	6	4	1.76	0.12	6	1.76	0.32	4	1.76	0.12	6	1.76	0.32
snimak	2	3	2	0.95	0.05	3	0.95	0.40	3	0.95	0.40	3	0.95	0.4
stav	6	10	8	2.22	0.26	9	2.06	0.35	8	2.06	0.31	8	2.06	0.31
stena	4	6	3	1.49	0.06	5	1.49	0.36	4	1.49	0.25	5	1.49	0.36
stepen	8	14	6	2.29	0.11	14	2.29	0.40	12	2.29	0.36	14	2.29	0.4
stopa	9	14	6	2.25	0.13	13	2.25	0.39	7	2.14	0.24	13	2.25	0.39
struja	6	8	5	2.00	0.14	8	2.00	0.33	6	1.89	0.27	7	2.00	0.29
struk	3	10	5	1.92	0.17	7	1.72	0.39	5	1.72	0.26	7	1.72	0.39
tabla	3	7	4	1.76	0.12	5	1.76	0.24	4	1.76	0.12	5	1.76	0.24
tačka	8	11	9	2.85	0.10	10	2.85	0.14	10	2.85	0.14	10	2.85	0.14

	a) Senses listed in the dictionary		**b) Senses listed by participants**			**c) Senses with mean familiarity rating>1.9**			**d) Senses with mode familiarity rating >1**			**e) Senses with median familiarity rating >1**		
	N1	**N2**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
talas	3	6	5	2.10	0.10	6	2.10	0.19	6	2.10	0.19	6	2.10	0.19
tekst	3	5	2	0.70	0.30	5	0.70	0.70	4	0.70	0.65	5	0.70	0.7
termin	3	3	2	1.00	0.00	3	1.00	0.37	2	1.00	0.00	3	1.00	0.37
teza	4	6	3	1.58	0.00	5	1.58	0.32	5	1.58	0.32	5	1.58	0.32
tezga	2	2	2	1.00	0.00	2	1.00	0.00	2	1.00	0.00	2	1.00	0
traka	5	5	4	1.73	0.13	5	1.73	0.25	3	1.23	0.23	5	1.73	0.25
ugao	4	6	3	1.53	0.04	6	1.53	0.41	6	1.53	0.41	6	1.53	0.41
ukus	2	4	4	1.93	0.03	4	1.93	0.03	4	1.93	0.03	4	1.93	0.03
uslov	2	2	2	0.90	0.10	2	0.90	0.10	2	0.90	0.10	2	0.90	0.1
uspon	4	6	3	1.32	0.17	6	1.32	0.49	6	1.32	0.49	6	1.32	0.49
vatra	9	11	6	2.25	0.13	11	2.25	0.35	9	1.97	0.38	11	2.25	0.35
venac	11	11	7	2.34	0.17	10	2.34	0.29	7	2.04	0.27	10	2.34	0.29
veza	5	11	9	2.86	0.10	11	2.86	0.17	11	2.86	0.17	11	2.86	0.17
visina	8	9	9	2.69	0.15	9	2.69	0.15	9	2.69	0.15	9	2.69	0.15
vrat	2	2	2	0.97	0.03	2	0.97	0.03	2	0.97	0.03	2	0.97	0.03
vreća	3	5	1	0.00	1.00	4	0.00	1.00	4	0.00	1.00	4	0.00	1
zakon	7	8	5	2.08	0.10	8	2.08	0.31	6	2.08	0.19	8	2.08	0.31
zglob	3	7	3	1.46	0.08	5	1.46	0.37	3	0.84	0.47	5	1.46	0.37
žica	8	11	6	2.43	0.06	10	2.43	0.27	6	2.43	0.06	9	2.43	0.23

	a) Senses listed in the dictionary		b) Senses listed by participants			c) Senses with mean familiarity rating>1.9			d) Senses with mode familiarity rating >1			e) Senses with median familiarity rating >1		
	N1	**N2**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**	**N**	**H**	**T**
znak	7	8	5	2.02	0.13	8	2.02	0.33	8	2.02	0.33	8	2.02	0.33
zrno	3	4	3	1.53	0.03	4	1.53	0.23	4	1.53	0.23	4	1.53	0.23
zvono	2	4	3	1.55	0.02	3	1.55	0.02	3	1.55	0.02	3	1.55	0.02

Nina Ilić Matijević
Department of English,
Faculty of Philosophy,
University of Novi Sad
nina.ilic.ns@gmail.com

UDC 811.163.41'367.625:81'232-053.4

UNACCUSATIVE, TRANSITIVE AND ANTI-CAUSATIVE VERB PRODUCTION IN THE PROCESS OF LANGUAGE ACQUISITION

Abstract: Cross-linguistic research into the acquisition of verbs has not been unanimous in its conclusions. The aim of the present research was to examine the order in which verbs with different argument structure are acquired (unaccusative, transitive and anti-causative verbs). Twelve verbs were tested (four verbs from each group). A total of eighteen subjects belonging to six age groups (18-21, 23-24, 31-33, 35-36, 39-44 and 48-52 months - three participants each) took part in the research. The data collection technique was a structured interview with a verb elicitation task. The children were asked to name the activities presented by toys and pictures. Though the sample was small, among-group differences were noted. Participants of the youngest age group (18-21) produced mainly transitive verbs (which show a subject-agent correspondence) and a few unaccusative verbs, but no anti-causative verbs. This tendency continued in the next group (23-24), but the participants performed considerably better. Anti-causatives (also one-place predicates) were first produced in the 31-33 months group. This group produced virtually all transitive and unaccusative verbs, but still had difficulty with anti-causative verbs. The production in the next three groups did not differ much, since the participants were successful in production across verb groups. The results show that children at a lower stage of speech development have more difficulty producing verbs with a complex argument structure (those which involve a complex syntactic process of derivation from a transitive verb), but not with unaccusative verbs, even though they also involve A-movement. In the process of acquisition, the production of anti-causative verbs is delayed. 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.

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

1. Introduction

The acquisition of the argument structure of verbs within the process of first language acquisition (LA) has raised a lot of interest. 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; Lorusso, Caprin & Guasti, 2005; Lee & Naigles, 2005; Costa & Friedmann, 2012), others show that the acquisition of verbs can be explained within the constructivist, usage-based theory (Braine, 1976; MacWhinney, 1978; Bowerman, 1990; Ninio, 1999; Lieven, Pine & Baldwin, 1997; Tomasello, 2003; Childers & Tomasello, 2001; Lieven, 2008).

The aim of the present research is to examine the order in which verbs with different argument structure are acquired (transitive, unaccusative and anti-causative verbs). Following Pinker's (1984, 1989) Canonical Linking Hypothesis, it is expected that transitive verbs are acquired first, followed by the acquisition of intransitive unaccusative verbs, and that 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, which involves 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. What needs to be stressed, however, is that the acquisition of syntactically complex verbs is not only a result of the innateness of semantic roles, but also of language input.

Regarding the structure of the paper, section 2 will deal with the theoretical background. First, the three tested types of predicates and their theta-roles will be presented, followed by their overview in Serbian. 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 research. Section 4 will deal with the analysis of the results obtained. Finally, in section 5, we will discuss the limitations of the study, summarize the main points of the research and provide suggestions for future research.

2. Theoretical background

2.1. On the syntactic and semantic complexity of verbs

2.1.1. Unaccusative, transitive and anti-causative 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, which can be the Agent θ-role (initiating the action) or the Theme θ-role (undergoes some change of state or position).

One-place predicates which assign the Theme θ-role 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).

Unaccusative verbs cannot assign accusative case to their argument. This was formalized as 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.

As opposed to unaccusative verbs, which have only an internal argument, transitive verbs have both an internal and an external argument. 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: [TP [vP John walked] [VP <V> the dog]] (Reinhart, 2000; Reinhart, 2002; Chomsky, 1995; Hale & Keyser, 1993). 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).

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. 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). Reinhart's Theta system (2000, 2002) provides a possible description of mapping theta roles to syntactic structures. It represents the interface between conceptual and computational (syntactic) system. Since it is a derivational 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 verb into an anti-causative one) as the "reduction of an external [+c] role". The external argument is removed before the remaining argument is merged internally. At the final step of the derivation, after the internal argument is merged as the sister of V [TP [vP broke] [VP <V> the branch]], it moves to a higher position of the specifier of TP, to become the subject.

2.1.2. Unaccusative, transitive and anti-causative verbs in Serbian

Serbian is a highly inflected language. Verbs are inflected for number, tense and, in the case of *perfekat*,[2] which is one of the past tenses, also for gender features. Moreover, they show agreement with the subject. The word order in Serbian is free, although the canonical order is SVO. Serbian is a pro-drop language, so the subject is often dropped. Both unergatives (1) and unaccusatives (2) exist in Serbian, although this difference cannot be noted in their morphology (Popov, 2013):

[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.

[2] *Perfekat* (the perfect) is formed by the verb *jesam* 'to be' in the present tense and *radni glagolski pridev* 'active participle' (l-participle), which is inflected for gender and number.

(1) Pas laje.
dog bark.3sg.pres
'The dog is barking.'
(2) Kiša pada.
rain fall.3sg.pres
'It is raining.'

As Tanasić (2005) points out, intransitive verbs cannot be passivized.

Transitive verbs in Serbian take two arguments and can be passivized (Tanasić, 2005). However, arguments can be dropped whenever they are recoverable from the context. As it has already been noted, Serbian is a highly-inflected, pro-drop language. Not only the subject, but the object can be dropped as well:

(3) Vozi.
drive.3sg.pres
'He/she is driving.'

Agreement with the subject is marked on the verb, but it can also be inferred from the context, together with the object.

In Serbian, anti-causative verbs are consistently marked with the morpheme *se* (4), which is not found with the transitive verbs they are derived from (5) (Popov, 2013):

(4) Vrata su se otvorila.
door.NOM SE open.3pl.past
'The door opened.'
(5) Dečak je otvorio vrata.
boy open.3sg.pres. door.ACC
'The boy opened the door.'

However, anti-causative verbs are not the only verb type which is marked with the morpheme *se*. The morpheme *se* is also found with reflexive, reciprocal and passive verbs. It implies the reduction of one argument in all these constructions. Although the derivational

operations of these constructions are different, the function of the morpheme *se* is most likely to absorb the accusative case (Franks, 1995; Progovac, 1997).

The aim of this section was to illustrate the relationship between theta-roles of predicates and different syntactic functions in a sentence. It was shown how the derivation of verb types differs depending both on the number of arguments that a verb takes and on verb semantics. All these issues influence the acquisition of verbs of distinct complexity, which will be discussed next.

2.2. Nativism

2.2.1. Semantic and Syntactic Bootstrapping

According to the generative theory of Universal Grammar (UG), outlined by Chomsky (1975, 1981 and 1986), all human beings are endowed with the knowledge of UG. LAD (Language Acquisition Device) is a 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 80s, the theory of principles and parameters was introduced as a framework in generative syntax, in which principles stand for the similarities between languages (they are universal), whereas parameters account for the structural diversity of natural languages (Chomsky, 1981).

Two different approaches to the acquisition of the argument structure can be distinguished within the generative framework. The underlying principles are shared by both, but different inducting mechanisms for the acquisition are defined, namely semantic and syntactic bootstrapping. 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). Pinker 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.

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. 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).

Nativism has 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 in contrast with Pinker's (1984, 1989)

ideas), others have argued that children possess early knowledge of argument structure. While the former approach supports the Maturation Hypothesis (Borer & Wexler 1987; Babyonyshev et al. 2001), the latter one supports the Continuity Hypothesis (Costa & Friedmann 2012; Lorusso, Caprin & Guasti 2005; Snyder, Hyams & Crisma 1995). These two approaches will be briefly discussed below.

2.2.2. Maturational delay – the Maturation Hypothesis

Borer and Wexler's (1987) influential study on the acquisition of movement speaks in favor of the 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-bar 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. A number of studies have confirmed this (Miyamoto et al., 1999; Lee & Wexler, 2001; Babyonyshev et al., 2001; Ito & Wexler, 2002).

Sano (2000), Sano, Endo & Yamakoshi (2001) and Sano (2003) provided opposing evidence for the acquisition of unaccusative and

passive verbs in Japanese. The children in their studies (from approximately 3 to 6 years old) 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 counterargument, 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.

2.2.3. 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, thus showing that unergative and unaccusative verbs are not analyzed in the same way. Other studies also showed that children are able to make a difference between unergative and unaccusative verbs from the earliest age, since they use them in different syntactic contexts (Lorusso, Caprin & Guasti 2005; Costa & Friedmann 2012).

The problem which children have with passive constructions, as opposed to unaccusative constructions, was explained without relying on the ACDH. 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 accept 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 (dative or prepositional case), whereas the promoted object gets structural features (nominative case). This problem slowly decreases with age.

2.3. Usage-based theory

2.3.1. 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 an 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 within the cognitive linguistics framework, Tomasello (2003) argues that experience is crucial for acquisition. Moreover, he claims that acquisition happens through the 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 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 study 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), which is why she believes 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 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 have shown (Huttenlocher, Smiley, & Charney, 1983).

Anđelković (2012) listed the existential *imati* "have" as perceptively unavailable. However, it seems that all unaccusative verbs are perceptively unavailable without the entity they are referring to.[3] 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 verbs with the least number of arguments are acquired first (Fisher, Hall, Rakowitz, & Gleitman, 1994).

Taking into consideration both the nativist and the usage-based account, as well as the studies conducted within these two frameworks, we 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), we expect that the results of the present research could replicate this finding, especially because 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). We also expect that the

[3] It is possible that there is a hierarchy of perceptive availability of verbs, since psychological verbs like *love* or *wait* seem to be even less perceptively available than unaccusative verbs like the existential *imati* "have".

youngest participants will be most successful with transitive verbs, which is in accordance with canonical linking rules (Pinker, 1984, 1989). We do not expect, however, that children will produce anti-causative verbs correctly at the earliest stage of acquisition, because anti-causative verbs involve a complex syntactic process of derivation from a transitive verb. If these hypotheses prove to be true, they will speak in favour of the nativist theory, which predicts that children use unaccusative and transitive verbs from the earliest age, but have problems with syntactically more complex structures such as passive and anti-causative verbs. Therefore, we are more prone to accept the nativist approach at this point.

3. The study

3.1. Subjects

The participants in the main experiment were 18 monolingual Serbian-speaking children ranging in age from 1;6 to 4;4. The children belonged to six age groups 18-21, 23-24, 31-33, 35-36, 39-44 and 48-52 months. Mean ages per group were approximately 20, 24 32, 36, 41 and 50 months, respectively. There were ten boys and eight girls tested, three participants in each group of respondents. None of the children selected had any language impairment or learning disability. Kindergarten teachers provided all the children's relevant information (e.g. the child's birth date). Children were tested in March 2015, in „Mrvica" kindergarten, „Radosno detinjstvo" preschool facility in Novi Sad.

3.2. Method and Stimuli

The participants performed a verb elicitation task. For this purpose, twelve verbs were chosen. The experiment consisted of two parts in which different stimuli were used. Puppets/toys were used to elicit verbs in the first part of the experiment, while colored drawings were used in the second part. Three verb types were tested in each part

of the experiment: simple transitive, unaccusative and anti-causative verbs. The interviewer's descriptions and questions were prepared in advance in order to prevent using the words that were being elicited from the children.

In the first part of the experiment, three simple transitive verbs (*jesti* 'eat', *piti* 'drink', *pevati* 'sing'), two unaccusative verbs (*pasti* 'fall', *svetleti* 'flash') and two anti-causative verbs (*zatvoriti se* 'close', *ugasiti se* 'turn off') were tested. Thus, there were a total of seven verbs tested in this part. An example of a toy used as an item (*svetleti*'flash') is given in Figure 1.

Figure 1 - Toy stimulus for *svetleti* 'flash'

In the second part of the experiment, one simple transitive verb (*voziti* 'drive'), two unaccusative verbs (*imati* existential 'have', *pući* 'pop/burst') and two anti-causative verbs (*otvoriti se* 'open', *pokvariti se* 'break') were tested, i.e. five verbs in total. The verbs were distributed in this way because it was easier to present some events with toys (e.g. 'flash'), whereas others were depicted more easily with drawings (e.g. 'drive'). An example of an item ('drive') is given in Figure 2.

Figure 2 - Drawing stimulus for *voziti* 'drive'

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. A sample parental consent form is given in Appendix 1. Eighteen 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, the interviewee and occasionally the kindergarten teacher, which was inevitable, since some children were reluctant to participate without their teacher accompanying them. Occasional interruptions were unavoidable. External noise was also present in some cases because the children in the kindergarten would move from one room to another or go outside. However, this did not have an influence on conducting the experiment. Other difficulties included children who avoided answering the question or started talking about a different topic. Some children also needed additional encouragement to start responding to the given stimuli. However, most children showed considerable interest most of the time and it was not difficult to focus their attention on the task.

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,[4] 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: And look at the teddy-bear, see what the teddy-bear is doing, the teddy bear is very hungry... He's got a stomach ache, and he has to take this now... (munching). What is he doing?
> Child: Eating."

The second part of the interview consisted of questions related to drawings. Each visual stimulus included two related pictures presenting a single situation. All the stimuli are given in Appendix 2. 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."

An example of the whole interview is given in Appendix 3. 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] Situation is used as a term for actions, states and occurrences (Comrie 1976).

3.4. Coding

Every interview was transcribed following the rules of the CHILDES transcription system. Answers were coded as 'target' when the children produced the target verb, or 'non-target' when they did not give an answer or produced a non-target word. Self-corrections were allowed. Closely synonymous verbs, which belong to the same verb type, and therefore have the same number of arguments, were also accepted as target. Non-target answers were codified in the following way:

1. Nouns/pronouns instead of verbs (e.g. *auto* 'car' instead of 'break')
2. Onomatopoeic answers (e.g. *bum* 'boom' instead of 'pop')
3. Repetition (e.g. *šta je bilo s loptom* 'what happened to the ball' as a response to 'what happened to the ball?')
4. Non-target verbs (e.g. *ne radi* 'doesn't work' instead of 'turn off')
5. Incomprehensible (babbling)
6. Gestures (e.g. imitating the situation of putting instead of 'popping')
7. No answer
8. Other (adjective *otvorena* 'open' instead of the verb 'open')

Studies have shown that children at an early age produce more nouns than verbs (Gentner, 1982). That is why the number of nouns and verbs produced in the two youngest groups (in which the children often produced nouns instead of verbs) was calculated. Only types were counted, not tokens.

4. Results

4.1. Group 1

4.1.1. Overall production of verbs

Three boys were tested in this group (URO 1;6; MAK 1;9 and ALE 1;9). ALE produced four target verbs (two transitive and two unaccusative), whereas MAK produced three (two transitive and one unaccusative) and URO produced only one target-verb (transitive). The participants of the youngest age group were most successful in producing transitive verbs, which show a subject-agent correspondence and support the Canonical Linking Hypothesis (Pinker, 1984, 1989). Three unaccusative verbs were also produced, but there were no anti-causative target verbs, as expected. Thus, the initial hypothesis that children at a lower stage of speech development have more difficulty producing verbs with a complex argument structure was confirmed. The results are given in Figure 3.

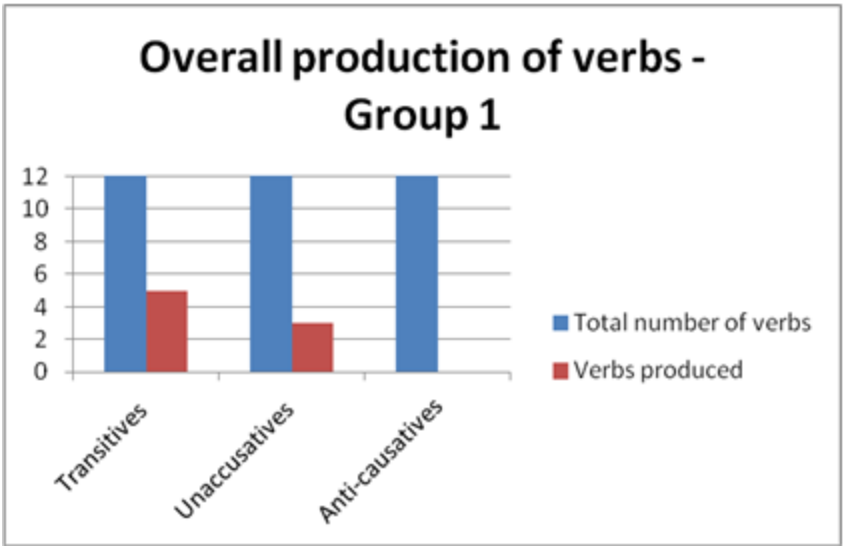

Figure 3 - Overall production of verbs Group 1

4.1.2. Production of nouns and verbs

It is relevant to point out that the children in this group often produced nouns instead of verbs in their answers. For that reason, the percentage of nouns and verbs produced was counted (repeated words were not included). As it can be seen in Figure 4, the production of nouns and verbs was virtually equal for ALE and URO and in favor of verbs for MAK. This shows the children's inclination towards nouns at this age, if we take into account that the questions in the interview were intended to elicit verbs as answers. The results are in accordance with previous research (Gentner, 1982; Naigles and Hoff, 2006), since nouns have a more transparent mapping to the perceptual-conceptual world. However, many studies have shown that not all languages are noun-biased (Tardif, 1996; Kim et al., 2000). The reason for this discrepancy may lie in the input (Naigles and Hoff-Ginsberg, 1998).

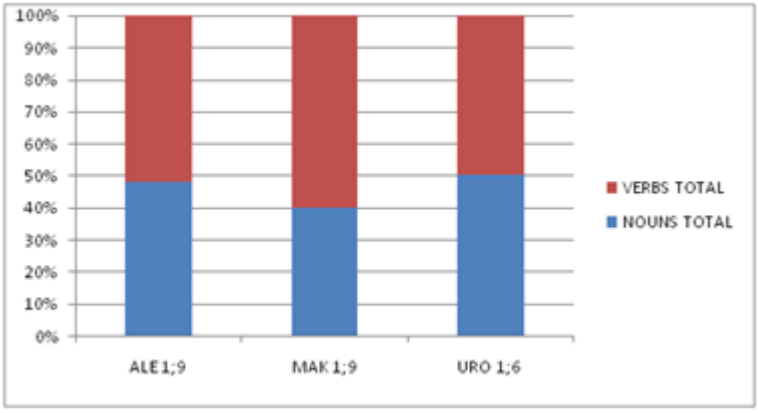

Figure 4 - Verb and noun production Group 1

4.2. Group 2

4.2.1. Overall production of verbs

Three girls were tested in this group (NIN 1;11; NEV 2;0 and MIL 2;0). NEV produced six target verbs (four transitive and two unaccusative verbs), whereas MIL and NIN produced four (three

transitive and one unaccusative). The participants in this group performed considerably better in comparison with the participants from the previous group. The children were again most successful in producing transitive verbs. The production of unaccusative verbs was still quite low. There were still no anti-causative verbs. The results are given in Figure 5.

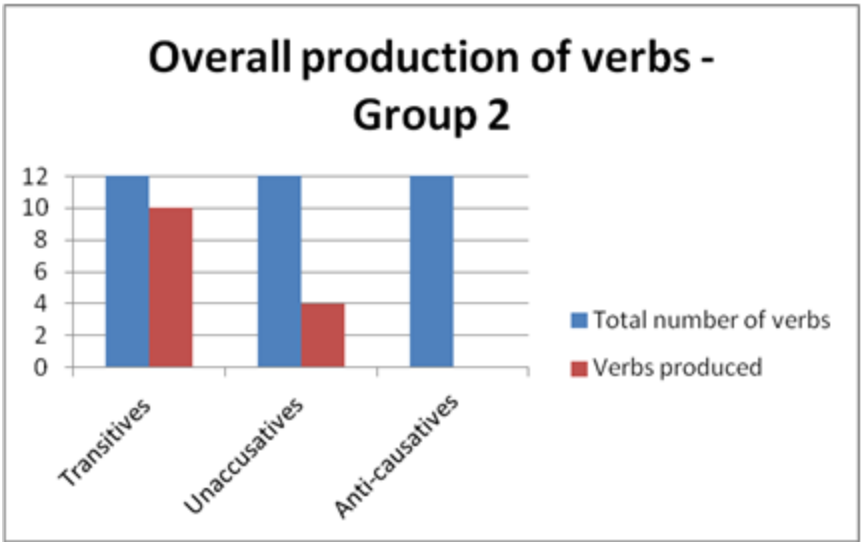

Figure 5 - Overall production of verbs Group 2

4.2.2. Production of nouns and verbs

For the same reason as for the previous group, the percentage of nouns and verbs produced was calculated. As it can be seen in Figure 6, the production of nouns and verbs was not the same as for the previous group. Only NIN produced an equal number of nouns and verbs. NEV also produced nearly the same amount of nouns and verbs. However, MIL produced a much greater number of verbs.

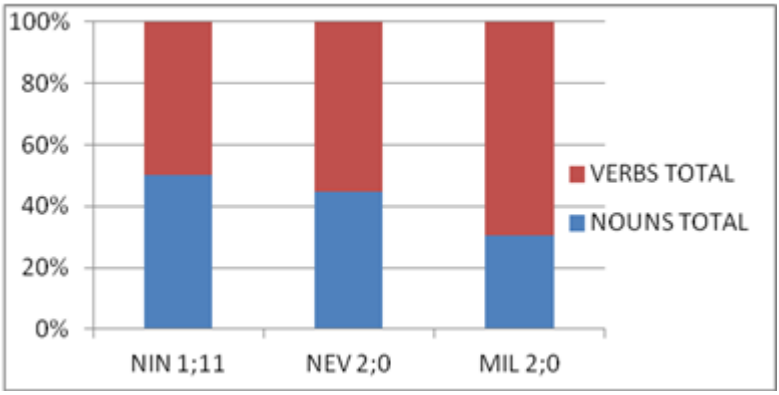

Figure 6 – Verb and noun production Group 2

4.3. Group 3 - Overall production of verbs

The participants in this group were one girl (MIL 2;7) and two boys (STR 2;8 and DAN 2;9). MIL produced nine verbs (four transitive, three unaccusative and two anti-causative verbs). STR also produced nine verbs (three transitive, four unaccusative and two anti-causative verbs). DAN was the most successful in the production of verbs. He produced all the verbs tested. Overall verb production was considerably higher than the production in the previous two groups. As it is presented in Figure 7, the production of unaccusative verbs increased and it was as high as the production of transitive verbs. Anti-causative verbs occurred for the first time in this research and their production was surprisingly high.

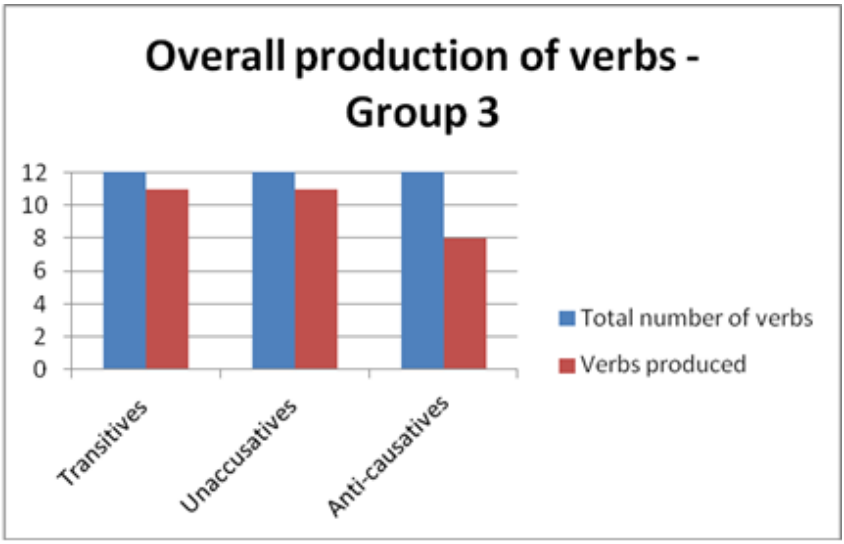

Figure 7 – Overall production of verbs Group 3

4.4. Group 4 - Overall production of verbs

One girl (LEN 2;11) and two boys (OGN 3;0 and DUS 3;0) were tested in this group. LEN produced eight target verbs (two unaccusative, four transitive and two anti-causative verbs). OGN produced all the target verbs. DUS produced eleven target verbs (three unaccusative, four transitive and four anti-causative verbs). Figure 8 shows that the production of transitive verbs was again the highest, since all the participants produced all the target transitive verbs. The production of unaccusative verbs was the lowest. As opposed to the previous groups, this group was very successful in the production of anti-causative verbs.

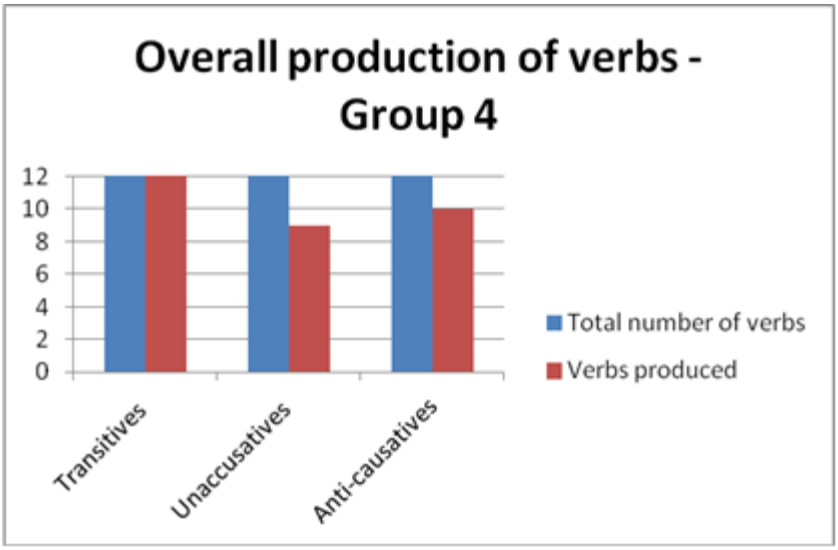

Figure 8 – Overall production of verbs Group 4

4.5. Group 5 - Overall production of verbs

Two girls (MIL 3;3 and TEO 3;4) and one boy (VUK 3;8) were tested in this group. MIL produced nine verbs (three unaccusative, four transitive and two anti-causative verbs). VUK produced eleven verbs (four unaccusative, four transitive and three anti-causative verbs) and TEO produced all the verbs. The children had no problems producing any type of verbs in particular. The production of transitive verbs was again the highest, since all the participants produced all target transitive verbs. The production of unaccusative verbs was successful as well and only slightly lower than the production of transitive verbs. The production of anti-causative verbs was somewhat lower, as it is shown in Figure 9.

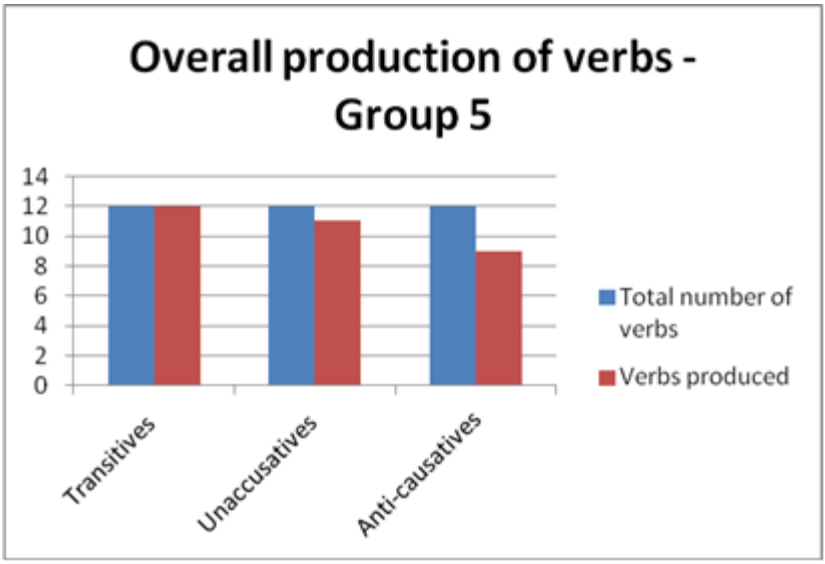

Figure 9 - Overall production of verbs Group 5

4.6. Group 6 - Overall production of verbs

Two boys (NIK 4;0 and VUK 4;3) and one girl (MIL 4;4) were tested in this group. NIK produced ten verbs (four unaccusative, four transitive and two anti-causative verbs). VUK produced eleven target verbs (three unaccusative, four transitive and four anti-causative verbs) and MIL produced all the target verbs. This group was the most successful one in the production of verbs. The children produced verbs with different argument structures without difficulty. All transitive verbs were produced. There were only one unaccusative and two anti-causative verbs which were not produced, as shown in Figure 10.

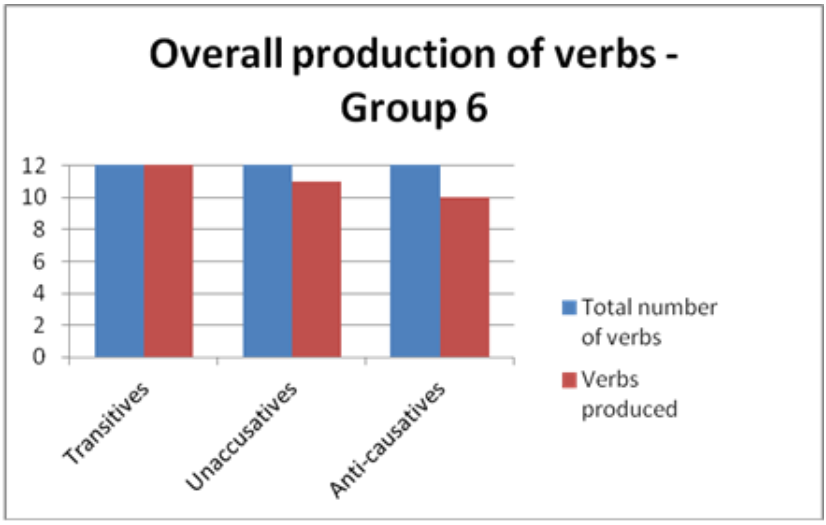

Figure 10 - Overall production of verbs Group 6

4.7. Transitive verb production across groups

As it can be seen in Table 1, transitive verbs were produced from the youngest group tested. As expected, the production of transitive verbs was more successful than the production of any other verb type tested, because transitive verbs show canonical linking of thematic roles and syntactic functions (Pinker; 1984; 1989). The verbs *jesti* 'eat' and *voziti* 'drive' were produced by two participants. The production was not as good for the verb *piti* 'drink', which was produced only by one participant. There were no answers for *pevati* 'sing'.

There was a great increase in the production of transitive verbs in Group 2. The trend of a better production of transitive than any other type of verbs continued in this group as well, but the participants' performance was far more successful. The verbs *jesti* 'eat' and *piti* 'drink' were produced by all the participants, as well as the verb *voziti* 'drive'. Whereas there were no correct answers for the verb *pevati* 'sing' in the previous group, there was one correct answer in this group.

In the remaining groups, the participants had no difficulty producing this type of verbs. In Group 3, the verbs *jesti* 'eat', *piti*

'drink' and *voziti* 'drive' were produced by all the participants. The only verb that was produced by two participants was the verb *pevati* 'sing'. Transitive verbs were the only type verbs that reached maximum production in three of the six groups tested – Groups 4, 5 and 6.

Table 1. Transitive verb production across groups

Target verbs/ Groups	***jesti* 'eat'**	***piti* 'drink'**	***pevati* 'sing'**	***voziti* 'drive'**	**Total number of verbs produced**
Group 1	2	1	0	2	5
Group 2	3	3	1	3	10
Group 3	3	3	2	3	11
Group 4	3	3	3	3	12
Group 5	3	3	3	3	12
Group 6	3	3	3	3	12

4.8. Unaccusative verb production across groups

The production of unaccusative verbs was not as successful as the production of transitive verbs in Group 1. The verbs *pasti* 'fall', *pući* 'pop/burst' and *imati* 'fall' were produced once. There were no responses for the verb *svetleti* 'flash'.

Unlike the production of transitive verbs, the production of unaccusative verbs did not double in Group 2, as it can be seen in Table 2. It was again considerably lower than the production of transitive verbs. The only verb for which the production was notably higher was the existential verb *imati* 'have', which was produced by all the participants. The verb *pasti* 'fall' was produced only once. There were no responses for the verbs *svetleti* 'flash' and *pući* 'pop/burst'.

However, the production of unaccusative verbs was quite high in Groups 3, 4, 5 and 6, although the production was somewhat lower in Group 4, as shown in Table 2. In Group 3, the verbs *pasti* 'fall', *imati* 'have' and *pući* 'burst/pop' were produced by all the participants. The verb *svetleti* 'flash' was produced by two participants.

In Group 4, the verb *pasti* 'fall' was not produced only by one participant, who replaced it with another unaccusative verb *nestati* 'disappear'. Surprisingly, the verb *svetleti* 'flash', which was not produced in the first two groups and was produced by two participants in the previous group, was produced by all the participants in this group. The existential verb *imati* 'have' was also produced by all the participants. On the other hand, the verb *pući* 'pop/burst' was produced only once. However, this verb was replaced with the verb *probušiti se* 'pierce' by two participants. The verb *probušiti se* 'pierce' could semantically correspond to the situation described, but is syntactically more complex, and could therefore not be coded as target.

In Group 5, the verbs *pasti* 'fall', *imati* 'have' and *svetleti* 'flash' were produced by all the participants. The verb *pući* 'pop/burst' was produced by two participants. One participant replaced this verb with the anti-causative verb *pocepati se* 'tear', which could semantically correspond to the situation described (like the verb *probušiti se* 'pierce' from the previous group), but is syntactically more complex, and could therefore not be coded target. Finally, in Group 6, the verbs *pasti* 'fall', *svetleti* 'flash' and *pući* 'pop/burst' were produced by all the participants, whereas the verb *imati* 'have' was produced by two participants.

Table 2. Unaccusative verb production across groups

Target verbs/ Groups	***pasti* 'fall'**	***svetleti* 'flash'**	***imati* 'have'**	***pući* 'pop'**	**Total number of verbs produced**
Group 1	1	0	1	1	3
Group 2	1	0	3	0	4
Group 3	3	2	3	3	11
Group 4	2	3	3	1	9
Group 5	3	3	3	2	11
Group 6	3	3	2	3	11

4.9. Anti-causative verb production across groups

The production of anti-causative verbs was delayed. Anti-causative verbs were not produced in the first two groups at all. As shown in Table 3, their production greatly increased in Group 3, after which it only slowly increased. The verb *zatvoriti se* 'close' was produced by all the participants. The verb *ugasiti se* 'turn off' was more difficult and was produced only once. The verbs *otvoriti se* 'open' and *pokvariti se* 'break' were produced by two participants.

In Group 4, the verbs *zatvoriti se* 'close' and *otvoriti se* 'open' were produced by all the participants, whereas the verbs *ugasiti se* 'turn off' and *pokvariti se* 'break' were produced by two participants. In Group 5, the production was a bit lower than the production in the previous group. Only the verb *ugasiti se* 'turn off' was produced by all the participants. The verbs *zatvoriti se* 'close', *pokvariti se* 'break' and *otvoriti se* 'open' were produced by two participants.

The production in Group 6 was a bit lower than the production of other verb types in this group. The verbs *ugasiti se* 'turn off' and *otvoriti se* 'open' were produced by all the participants. The verbs *zatvoriti se* 'close' and *pokvariti se* 'break' were produced by two participants. What has to be pointed out though is that one participant actually produced the passive forms of the verbs *zatvoriti se* 'close' and *ugasiti se* 'turn off'. Since passive verbs also have one argument which is a theme, these answers were coded as target.

Table 3. Anti-causative verb production across groups

Target verbs/ Groups	***zatvoriti se* 'close'**	***ugasiti se* 'turn off'**	***otvoriti se* 'open'**	***pokvariti se* 'break'**	**Total number of verbs produced**
Group 1	0	0	0	0	0
Group 2	0	0	0	0	0
Group 3	3	1	2	2	8
Group 4	3	2	3	2	10
Group 5	2	3	2	2	9
Group 6	2	3	3	2	10

4.10. Overall verb production 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 Figure 11, we can see that there was a great increase in the production of transitive verbs in Group 2, after which the participants had no difficulty producing this type of verbs. Unlike the production of transitive verbs, the production of unaccusative verbs did not double in Group 2. However, it was quite high in Groups 3, 4, 5 and 6, although the production was somewhat lower in Group 4. Figure 11 also shows that the production of anti-causative verbs was delayed. Anti-causative verbs were not produced in the first two groups. Their production rocketed in Group 3, after which it only slowly increased.

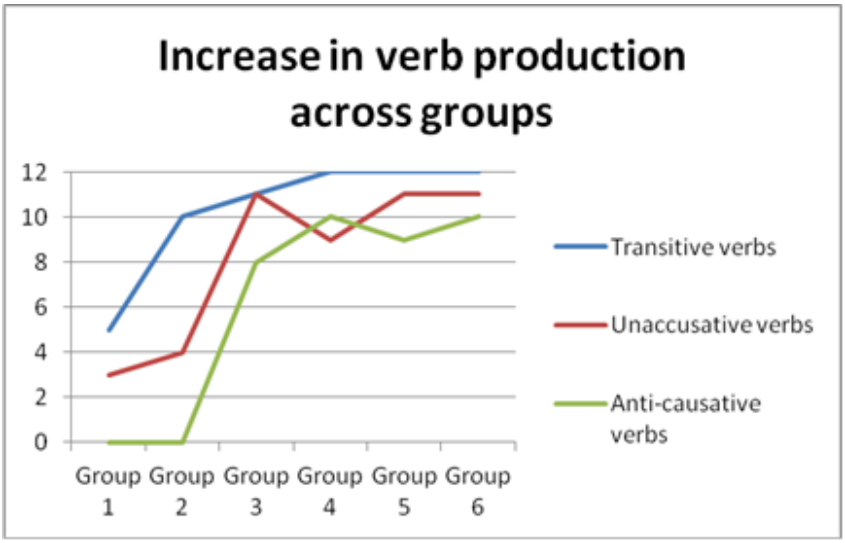

Figure 11 -Verb production across groups

4.11. Non-target answers across groups

The list of non-target answers includes the following: nouns/pronouns, onomatopoeic answers, incomprehensible answers, repetition, non-target verbs, gestures, no answers, other.[5]

Nouns/pronouns usually involved referents that were truly present in the extralinguistic reality, i.e. toys or drawings (*auto* 'car', *voda* 'water', *čika* 'uncle', *kutija* 'box') or referents that were not presented in the stimuli (*ništa* 'nothing', *voda* 'water', *tata* 'dad'). Alternatively, the respondents would refer to what they heard in the extralinguistic reality (e.g. *pap(r)iku* 'pepper', which appeared in the song used as a stimulus for the verb *pevati* 'sing'). In Table 4 (Appendix 4), we can see that the number of nouns/pronouns used as alternative answers decreased in Group 3. There was only one pronoun (*nešto* 'something') that was used instead of the target anti-causative verb *otvoriti se* 'open'. Nouns/pronouns were not used as alternative answers in the remaining three groups.

Onomatopoeic answers (*bum* 'boom' - imitation of the sound of a balloon popping) and gestures were only present in Group 2. Incomprehensible answers were present in the youngest two groups. Repetition included word-for-word copying of the words of the interviewer (*dođi (da) vidimo* 'come.imp (to) see.1pl.pres'; *šta je bilo* 'what happen.3sg.past') or copying the lyrics of the song used as a stimulus for the verb *pevati* 'sing'. Repetition was not present in Groups 4, 5 and 6.

The syntactic complexity of the non-target verbs used differed across groups. In the first three groups the participants replaced syntactically more complex verbs with less complex ones (only in two cases were they replaced with verbs of the same syntactic complexity). In Group 1, non-target verbs were the unaccusative verb *palo* 'fallen.-3sg.past' instead of the target unaccusative *svetleti* 'flash'; the transitive verb *gasila si* 'turned off.-2sg.past' instead of the target anti-causative *ugasiti se* 'turn off'; the transitive verb *sipaj* 'pour. imp'

[5] Only the child's first answer was analyzed.

instead of the target transitive *piti* ‘drink’. In Group 2, non-target verbs were the unaccusative verb *pala je* ‘fall.3sg.past’ instead of the target anti-causative *otvoriti se* ‘open’; the unaccusative verb *ne radi* ‘not function.3p.sg.pres’ instead of the target anti-causative *ugasiti se* ‘turn off’; the transitive verb *k(v)ataj* ‘catch.imp’ instead of the target unaccusative *svetleti* ‘flash’. In Group 3, non-target verbs were the unergative verb *kače* ‘jumps.3sg.pres’ instead of the target unaccusative verb *svetleti* ‘flash’ and the unaccusative verb *nema* ‘not have.3sg.pres’ instead of the target anti-causative verb *ugasiti se* ‘turn off’.

However, non-target verbs in Groups 4, 5 and 6 were not syntactically simpler. On the contrary, most of them were either of the same syntactic complexity or even more complex. In Group 4, three target unaccusative verbs were replaced with non-target verbs. The unaccusative verb *pasti* ‘fall’ was replaced by the unaccusative verb *nestati* ‘disappear’, whereas the unaccusative verb *pući* ‘burst/pop’ was replaced by the anti-causative verb *probušiti se* ‘pierce’ by two participants. These answers could not be coded as target, because the verb *nestati* ‘disappear’ has a completely different meaning from the verb *pasti* ‘fall’, and the verb *probušiti se* ‘pierce’ belongs to a different verb type. The only non-target verb which was syntactically less complex than the target verb was the unaccusative verb *nemati* ‘not have’, which was used instead of the anti-causative verb *ugasiti se* ‘turn off’. In Group 5, non-target verbs were the anti-causative verb *pocepao se* ‘tear.3sg.masc.past’ instead of the target unaccusative verb *pući* ‘pop/burst’; and the transitive verb *popravila* ‘fixed.3sg.fem.past’ instead of the anti-causative verb *zatvoriti se* ‘close’. In Group 6, the unaccusative verb *izgorio* ‘burnt.3sg.masc’ was used instead of the target anti-causative verb *pokvariti se* ‘break. Therefore, there were fewer non-target verbs in Group 6 than in any of the previous groups.

Non-target answers which were categorized as ‘other’ in the first three groups include the interjection *da* ‘yes’, the adverb *tu* ‘here’, the adjective *otvoreno* ‘opened’ and the construction *ne znam* ‘I don’t know’. However, in the remaining three groups, answers belonging to this category were much more syntactically complex. An overview of

the non-target answers per type and per group of participants is given in Appendix 4.

4.12. Verb morphology

Verb morphology present in this study is also in agreement with previous conclusions related to aspect (Armon-Lotem & Berman, 2003). Verb morphology in Groups 1 and 2 included affixes for present and past tense and imperatives. Past forms were used for perfective actions, whereas present forms were used for imperfective/durative actions. Children used adequate tense morphology on the verbs, which indicates that from the earliest age they can recognize verbs as members of a coherent syntactic category, different from that of nouns. Although the target answers were all in the third person singular form, from Table 4 we can see that other forms of verbs were also present from the earliest age. However, an experiment which would include a variety of forms is needed in order to confirm these findings.

From Group 3 onwards, the participants consistently produced present and past verb morphology. They also used much more complex structures than the participants in the previous groups. They did not use imperatives anymore. There were some omissions of auxiliary verbs, as exemplified in (6) and (7). These omissions were not present in the two youngest groups, which was expected since the children's production was not developed enough.

(6) Pala (je).
fall.3sg.fem.
'It fell.'

(7) Zatvolila (su) se.
close.3pl.past SE
'They closed.'

Moreover, there were occasional mismatches in noun-verb agreement, as exemplified in (8).

(8) Zatvorili su se vrata.
close.3pl.past.**masc.**SE door.NOM.**fem.**
'The door closed.'

Omissions of auxiliary verbs slowly decreased, and were not very not frequent in Groups 5 and 6.

5. Discussion and suggestions for future research

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 and verbs in the study was limited. Our initial intention was to test at least five children in each group. However, we did not manage to ensure enough parental consent forms. Therefore, the results obtained should be taken with caution until a study with a larger number of participants is conducted. Moreover, there is a danger of noticing generational differences in transversal studies (Jerković & Zotović, 2010), which is why longitudinal studies give a more realistic insight into individual development. However, the CHILDES corpus could not be used in the present research. The main reason for this is that we did not find enough occurrences of each verb type we wanted to test in spontaneous parent-children conversations. For these reasons, we designed an experiment to test children's production of verbs in different age groups.

Another drawback of the present research is the fact that the frequencies of the target verbs in child language could not be explored in detail. The *Frequency Dictionary of Child Language* (Lukić, 1983) is available in Serbian. However, this frequency dictionary was made 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 the nature-nurture debate

The aim of this research study was to examine the order in which verbs with different argument structure are acquired (unaccusative, transitive and anti-causative verbs), in order to get an insight into the way children acquire verbs of different complexity. Some important developmental changes were noted. The youngest group produced nouns instead of verbs in many cases, which is in accordance with previous research, since nouns have a more transparent mapping to the perceptual-conceptual world (Gentner, 1982). Participants of this age group produced mainly transitive verbs (which show a subject-agent correspondence) and a few unaccusative verbs, but no anti-causative verbs. This tendency continued in the next group, but the participants performed considerably better. Anti-causatives, which are also one-place predicates, were first produced in Group 3. This group produced virtually all the unaccusative and transitive verbs elicited, but still had difficulty with anti-causative verbs. The production in Groups 4, 5 and 6 did not differ significantly. Participants were successful in production across verb groups, although they occasionally preferred the transitive verb to the anti-causative one or made a mistake with anti-causative verb morphology.

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 anti-causative verbs. Reflecting on the debate whether unaccusative verbs are learnt early (Snyder, Hyams & Crisma, 1995; Lorusso, Caprin & Guasti, 2005; Snyder and Hyams, 2008; Costa & Friedmann, 2012) or whether there is a maturational delay with A-chains (Borer and 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 seem to support maturational delay, since unaccusative verbs were produced even by the youngest participants. However, the results

obtained in this study are not enough either to support the Continuity Hypothesis or to completely reject the Maturational Hypothesis, since there are no overt morphological or syntactic differences in the usage of unergative and unaccusative verbs in Serbian. Therefore, we cannot make any claims regarding the children's (in)ability to distinguish between unergative and unaccusative verbs at the earliest age.

At this point, it remains unclear whether the difficulty with anti-causative verbs can be attributed to the children's problem with the formation of A-chains or whether it lies in linking the surface subject with an underlying object position, as Snyder and Hyams (2008) suggested for passive constructions. Moreover, the external argument is removed before the remaining argument is merged internally (Reinhart & Siloni, 2005), which may pose an additional problem for children, who may prefer the transitive variants of anti-causative verbs. This is why further research is needed in this field.

It is of paramount importance to mention that the participants used adequate tense morphology on the verbs 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 seems to support the nativist approach and speak 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 in the target answers of the participants in this study provides evidence that children are able to generalize from the earliest age. Moreover, as it was mentioned before, children's non-target answers included other verb forms as well. However, a study which would test other verb forms is needed in order to confirm these findings.

Finally, the results should be taken with caution, since the number of participants in the study was very limited. Since only longitudinal studies allow a reliable insight into the individual development of children, such a study would make a contribution towards a more complete understanding of the nature of verb acquisition. Collecting an extensive corpus of child language in Serbian would be helpful in that sense, which is why that should be one

of the primary goals for future research into first language acquisition in Serbian.

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Appendix 1: Parental consent form (translated from Serbian)

PARENTAL CONSENT FOR PARTICIPATION OF A CHILD IN A RESEARCH STUDY: THE PRODUCTION OF VERBS WITH DIFFERENT ARGUMENT STRUCTURE IN THE PROCESS OF LANGUAGE ACQUISITION

This research study is conducted as a part of a master's thesis. The purpose of the research study is to investigate the order in which children acquire verbs with different argument structure (verbs that take as their argument(s) only a subject, a subject and an object or a subject and two objects). Because of this, the research study will be conducted with different age groups (ranging between 18 and 48 months). This research study is significant because it should confirm earlier findings in language acquisition. It should also provide novel data to the field.

If you agree to let your child participate in the research study, he/she will be asked to participate in a game and have a look at a few drawings. Then, the researcher will, in the form of an interview, ask the child a few questions that will be closely related to the presented material. The situations that will be presented to the child are, for example: the monkey is jumping, the teddy-bear is eating honey, the puppy is throwing the ball to the ant, etc. The children will be asked to name the actions, which will be done in the form of an interview. The researcher will be asking questions such as 'What is the teddy-bear doing?' 'What's the monkey doing?' Some situations will be performed by the researcher (e.g. the door closed, the light turned on). Furthermore, visual material (drawings) will be used for certain activities and the children will be asked to name the situations presented on them (e.g. the boy is running, the man is driving a car).

The research study will be conducted with children who are 18, 24, 30, 36, 42, and 48 months old. The interview with the children will be audio recorded by a tape recorder, so that the data could be subsequently analysed. The children will not be photographed nor video recorded.

Your child's participation in the research study is completely voluntary. Your child will not face any consequences if you refuse to allow him/her to participate in the research study. Moreover, it is of crucial importance to state that participating in the study will bring your child no harm. If your child feels uncomfortable during the interview, it will be immediately stopped.

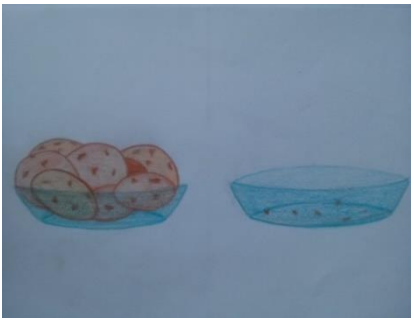
The data that are collected in this study will be used for scientific purposes exclusively. The audio recordings will be kept private and they will be available only to the researchers.

With your signature, you acknowledge that you have read and understood everything aforementioned and that you agree to give permission for your child's participation in the research study and the tape recording of the interview.

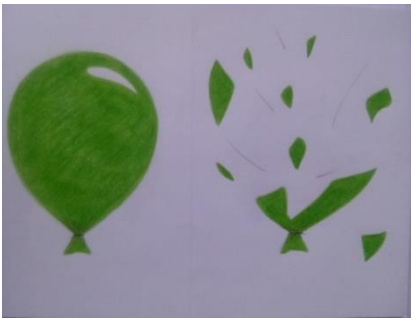
Appendix 2: Visual stimuli – drawings

voziti ‘drive’

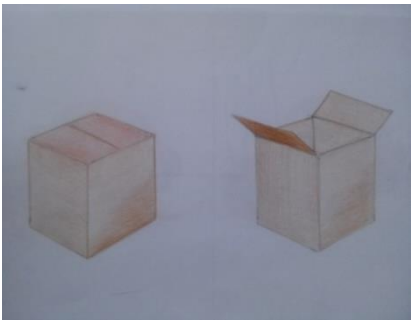
imati ‘have’



pući ‘pop/burst’



otvoriti se ‘open’



pokvariti se ‘break’

Appendix 3: Sample interview

Interviewer: *Vidi medu, gledaj sad šta meda radi, meda je jako gladan....Boli ga stomak, sad mora ovo da uzme...(mljackam) Šta on radi?*

Look at the teddy-bear, see what the teddy-bear is doing, the teddy bear is very hungry... He's got a stomach ache, and he has to take this now... (munching). What is he doing?

Child: *jede*

eat.3sg.pres

'Eating.'

Interviewer: *A slonić… on nije jako gladan, on je jako žedan, mora ovo da uzme, šta on radi? (srčem)*

And the little elephant... he is not very hungry, he is very thirsty, he has to take this, what is he doing? (sipping)

Child: *pije*

drink.3sg.pres

'Drinking.'

Interviewer: Sada *vidi mrava ... Vidi šta on radi: Išli smo u Afriku... – Šta on radi?*

Now, look at the ant... Look what he is doing: We went to Africa... – What is he doing?

Child: *sadi papriku*

plant.3.sg.pres pepper

'Planting a pepper.'

Interviewer: *Aha, ali sa pesmom šta radi? Jel ti znaš tu pesmu? Ajde da vidimo. (pevamo) Šta mi sad radimo, šta radimo s pesmom?*

Aha, but what is he doing with the song? Do you know the song? Let's see. (We are singing.) What is he doing now?

Child: *peva*

sing.3sg.pres

'Singing.'

Interviewer: *Bravo, super. Ju ... šta je bilo sad sa ovim (klupko je palo na pod)? Ha, šta bilo s tim?*

Bravo, great. Oh... What's happened to this now (a ball has fallen onto the floor)? Ha, what has happened to it?

Child: *ispalo na zemlju*

fall.3sg.neut on ground

'It has fallen onto the ground.'

Interviewer: *Mhm, super, ha, da ti pokažem lopticu. Svima se najviše sviđa loptica. Vidi sad, šta ona radi?*

Yeah, great, ha, let me show you this little ball. Everyone likes this ball the best. Look, what is it doing?

Child: *svetli*

flash.3sg.pres

'Flashing.'

Interviewer: *Jel ti se dopada?*

Do you like it?

Child: *da*

yes

'Yes.'

Interviewer: *Dobra je jel da, super je loptica. Važi, dođi ovamo. Vidi sad, šta se sad desilo sa vratima, gledaj? Šta se desilo s njima?*

It's good, isn't it? The ball is great. Okay, come here. Look, what's happened to the door now? Look. What has happened to it?

Child: *zatvorila (su) se*

closed.pl.fem. se

'It closed.'

Interviewer: *Mhm. A sa svetlom, gledaj sad šta se desilo sa svetlom?*

Ok. And what about the light; look, what's happened to the light?

Child: *ugasilo se*

turn off.3sg.past se

'It has turned off.'

Interviewer: *Bravo, ti si pametnica. Šta radi ovaj bata?*

Bravo, you are a smarty. What is this man doing?

Child: *vozi*

drive.3sg.pres

'Driving.'

Interviewer: *Šta je bilo ovde?*

What happened here?

Child: *pukao je balon*

burst.3sg.past balloon

'The balloon burst.'

Interviewer: *Šta se ovde desilo? A? Šta se desilo s autom?*

What happened here? M? What happened to the car?

Child: *pokidao se auto*

tear.3sg.past car

'The car tore.'

Interviewer: *A šta je ovde bilo sa ovom kutijom?*

And what happened to this box here?

Child*:* *stavila je tu loptu*

put.3sg.past there ball

'She put the ball there.'

Interviewer: *Ko? Ovde je kutija zatvorena, a šta joj se ovde desilo?*

Who? Here the box is closed, but what happened to it here?

Child: *otvorila se kutija*

open.3sg.past se box

'The box opened.'

Interviewer: *Ovde nema keksa. A ovde?*

There are no cookies here. But here?

Child: *ima keksa*

have.3sg.pres. cookies

'There are cookies.'

Interviewer: *Bravo. Hvala ti.*

Bravo. Thank you.

Appendix 4 - Non-target answers across groups

Non-target answers	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Nouns/pronouns	*čika* 'uncle' *auto* 'car' *voda* 'water' *tata* 'dad' pap(r)iku 'pepper' *voda* 'water' *niš(t)a* 'nothing'	*kutija* 'box' *auto* 'car' *papiku* 'pepper' *nić(t)a* 'nothing'	*nešto* 'something'	/	/	/
Onomatopoeia	/	*bum* 'boom'	/	/	/	/
Repetition	*dodji (da) vidimo* 'come.imp see.1pl.pres'	*šta je bilo* 'what happen.3sg.past'	*'on ide u pap(r)iku'* he.nom go.3sg.pres in pepper.acc'	/	/	/
Non-target verbs	*palo* fallen.3sg.past *si gasila* turned off.2sg.past *sipaj* pour. imp	*ne radi* not function.3sg.pres *pala je* fall.3sg.past *k(v)ataj* catch.imp	*kače* jump.3sg.pres *nema* not have.3sg.pres	*nestalo je* disappear *probušilo se* pierce.3sg.past SE *nema ga* has not.3sg.pres it	*pocepao se* tear.3sg.past SE *popravila* fix.3sg.past	*izgorio* burnt.3sg.masc
Incomprehensible	JAA@b MM@a	umutio se@	/	/	/	/

Gestures	/	for the verb *pući* pop/burst	/	/	/	/
Other	*Da* yes *tu* here	*otvoreno* opened	*ne znam* 'I don't know'	*mora da kupi baterije* must.3sg.pres DA buy.3sg.pres batteries.acc 'He must buy batteries'[7]	*istrošila se bat(eri)la* expend.3sg.fem. SE battery.NOM 'The battery expended. '[8] *Ovde su otvorili kocku* here open.3pl.past cube.ACC 'Here they opened the cube.'[9]	*Da* yes *da ih zatvorimo* to them.ACC close.1pl.pres. 'To close them.'[10]

[7] The participant preferred to use the modal and the ditransitive verb *kupiti* 'buy' (and therefore express volition of the agent) instead of the anti-causative verb *pokvariti se* 'break'.

[8] The participant used the anti-causative verb '*istrošiti se*' expend, but her interpretation was that the car drawn was a toy, which needed battery refilling.

[9] The participant preferred a transitive variant of the anti-causative verb *otvoriti se* 'open' with a non-overtly expressed agentive argument expressed on the verb, even though this was not presented on the drawing.

[10] The participant preferred a transitive variant of the anti-causative verb *zatvoriti se* 'close' with a non-overtly expressed agentive argument expressed on the verb.

Livia Šagi
Department of English, Faculty of Philosophy, University of Novi Sad
sagi.livia@gmail.com

UDC 811.111'367.52:
811.511.141'367.52]:81'232

THE ACQUISITION PROCESS OF WORD ORDER AND THE INFORMATION STATUS OF ARGUMENTS IN ENGLISH AND HUNGARIAN*

Abstract: Natural languages encode relations between constituents of an utterance in two ways: case marking inflections and word order. English does not have a rich inflectional system; therefore word order is needed to interpret sentences. Hungarian, on the other hand, has rich inflectional morphology, therefore the word order is flexible and its main function is to encode pragmatic information. The purpose of this paper is to determine the acquisition process of word order in English and Hungarian, as well as the ordering of arguments based on their information status. There are two frameworks for the study of language acquisition**:** the grammar-based parameter setting approach and the usage-based approach. Several studies have been reviewed to give an overview on the word order acquisition of English children. The overall conclusion is that English children mostly adhere to the default word order of their language. Three studies have been conducted to determine the acquisition of word order in Hungarian. The data were gathered from the CHILDES database. The findings support the initial hypothesis that Hungarian children use every variation of word order. However, they still prefer the default SVO and SOV orders to a significant extent. Regarding the ordering of arguments according to their information status, both English and Hungarian children tend to put arguments referring to discourse-new information first, which is then followed by arguments referring to old information. In the case of English children, previous research has been reviewed to arrive to this conclusion, while the Hungarian data were gathered from the CHILDES database and analysed for this study. The results were not statistically significant, yet they still displayed a general tendency to order elements from new to old information. Further research is needed with more data directly from informants to get more conclusive results.

* This paper is based on my MA thesis at the University of Novi Sad, under the supervision of Sabina Halupka-Rešetar.

Keywords: language acquisition, word order, information status, English, Hungarian

1. Introduction

There are two ways to encode relations between constituents of an utterance in natural languages. The first is case marking inflections and the other one is word order (the sequencing of constituents) (Akhtar, 1999). According to the grammatical functions of sentence constituents (subject, object, and verb), there are six ways to order them: OSV, OVS, SOV, SVO, VOS, and VSO (Langus & Nespor, 2010). Of all these, SVO and SOV constitute the default word order of the majority of the world's languages (Dryer, 2005). It can be concluded that there is an obvious preference for word orders where the subject precedes the object and the verb, and where the verb–object adjacency is preserved (as in both S–OV and S–VO) (Greenberg, 1978). When children are acquiring their first language, they have to determine the default word order from linguistic input in their community (Akhtar, 1999). Free word order languages like Hungarian pose an interesting issue when the process of acquisition is considered. The flexibility of ordering information is a strategy to signal the topic and focus in utterances (e.g. É. Kiss, 2004; Sarma, 2003). Therefore, the ordering of constituents belongs to the domain of pragmatics. It poses the question whether children resort to the default underlying word order of the language in the early stages of acquisition or whether they are aware of the information structure (IS) of their native language from the beginning and use its strategies correctly.

The purpose of this paper is to determine the acquisition process of word order in English and Hungarian, as well as the ordering of arguments based on their information status. Based on the nature of these two languages, it is expected that English children will adhere to the default word order of their language, while Hungarian children will use every variation at their disposal from the beginning of their syntactic development. When it comes to English, the conclusions are drawn from previous literature on the topic. For Hungarian, three

studies have been conducted on data from the CHILDES database. Section 2 reviews the relevant literature on language acquisition and information status of both English and Hungarian. Section 3 reviews existing studies on the acquisition of word order in English and Hungarian and the ordering of arguments based on their information status. In Section 4, the methodology for the studies on word order acquisition and information status in Hungarian is presented. The findings of these studies are presented in Section 5 and discussed along with the main generalizations concerning their importance in Section 6. Lastly, Section 7 summarizes the main points of the paper.

2. Language acquisition and information status

In this section the relevant theoretical background is discussed concerning the general acquisition process in English, the flexible word order acquisition, and finally the information status of elements in utterances in child language.

2.1. Frameworks for language acquisition

There are two main approaches to language acquisition, and more specifically, to the acquisition of word order. One is the grammar-based parameter setting approach, while the other is the usage-based approach. Meisel (1996) states that parameter theory, as part of universal grammar (UG), has been developed to account for universal as well as particular aspects of grammars (i.e. the principles of a language and the parameters). The second aspect, parameter setting, can be used to explain variation across languages during acquisition. Meisel then continues to explain that the developing language of any child must obey all the principles of UG. He claims that parameter setting is a quasiautomatic process during which one analyzes the data, determines their grammatical structure, which then triggers the parameter to be set accordingly.

The other approach to language acquisition is adopted by cognitive-functional linguistics or usage-based linguistics. It stipulates

that structures emerge from use (Tomasello, 2003). In contrast to the parameter setting hypothesis, "in usage-based approaches the grammatical dimension of language is a product of a set of historical and ontogenetic processes referred to collectively as grammaticalization" (Tomasello, 2003: 5). The central point of this theory is communication, and the symbols used to communicate are strung together into sequences, patterns of use emerge and combine into grammatical constructions. He claims that children's early language is largely item-based and from that they construct an adult-like set of grammatical structures with the help of extensive data heard during the acquisition process.

2.2. English word order and its acquisition

In the literature, English is referred to as a fixed word order language because the ordering of constituents is relatively fixed: SVO (Quirk et al., 1985). English does not have a rich inflectional system, therefore word order is essential in the sentence interpretation process, particularly with semantically reversible sentences such as *The girl pushed the boy* (Bates & MacWhinney, 1989). Although there can be some variation in the ordering (e.g. topicalization), the more peripheral an element is, the more freedom of position it has and the verb, subject, and object have the strictest limitations (Quirk et al., 1985). Regarding the acquisition of English word order, similar conclusions are reached in the majority of studies regardless of the theory they apply in the research process: English-speaking children produce word orders that are canonical in their language.

2.3. Acquisition of word order in flexible languages

During language acquisition, the first step in the development of syntax is the two-word stage and it starts at around age 1;6. Around this age children start to produce two-word combinations that express propositional information in a single communicative act. Speakers of any language produce these sentences in an order that is consistent with the language models they experience. Thus, a child acquiring

English will produce *baby eat* rather than *eat baby*. Children exposed to languages characterized as free word order languages adhere to a consistent pattern based on more frequently occurring adult patterns. They do not necessarily use all types of word order at the same rate as some of them are more frequent than others (Goldin-Meadow & Butcher, 2003). Some studies argue that children prefer the underlying word order of the language over the deviant ones (Platzack, 1996). Platzack (1996) conducted a study on Swedish L1 acquisition and found that verb raising almost always occurred in finite clauses in adult language. Another example is that children consistently produced the default negation-infinitive order in infinitival sentences. On the other hand, other authors claim that deviant word orders are more preferable (Snyder & Bar-Shalom, 1998).

Some researchers argue that pragmatics is acquired later than syntax in the process of linguistic development, i.e. morphosyntax is already present when children start forming sentences, but they need more input to develop pragmatics. Schaeffer (2000) found that Italian and Dutch 2-year-olds mark referentiality only optionally and they exhibit adult-like marking from age three. She argues that "the optional marking of referentiality is related to a child's immature pragmatic system" (Schaeffer, 2000: 67) Höhle, Berger and Sauermann (2014) claim that the development of the production and comprehension of linguistic markers of information structure seems to be a rather long process. The fairly slow developmental progress may be due to the fact that the correct production and understanding of encoding IS via linguistic means requires not only grammatical and pragmatic knowledge but also social-cognitive abilities.

However, other researchers argue that morphosyntax and pragmatics develop simultaneously. Avrutin and Brun (2001) claim that the assumption that children do not have access to pragmatics from the start is not true. They investigated Russian children and found that before the age of two, children are able to correctly mark referentiality, which is a pragmatically dependent feature. They argue that pragmatic components develop at the same time as morphosyntax. Dyakonova (2004) claims that children have access to information structure components from a very early age and that pragmatics is acquired

simultaneously with syntax and not consecutively. She conducted a cross-linguistic study on a native English and native Russian speaker and compared their acquisition of word order. The results indicate that the Russian child (from age 1;6) used both VO and OV word orders and she did this to correctly mark the informational status of sentence constituents. The English-speaking child only produced the possible VO order. However, she produced instances of VS orderings that were not treated as mistakes by the researcher but rather as examples of focus preposing or do-support in elliptical sentences to emphasize the verb. The conclusion is that this pragmatic ability is not language specific but rather universal. A study conducted on Tamil, a flexible word order language from the Dravidian family, claims that children are aware of the IS functions of the different word orders and use them in an adult-like manner (Sarma, 2003). The study observed ten children acquiring Tamil between the ages of 1;5 and 3;8. They correctly used word order permutations to signal the topic and focus of sentences from the age of 1;8 when they first started constructing multi-word utterances. This means that the children acquired pragmatic strategies in the early stages of linguistic development, and used them simultaneously with syntactic operations.

2.4. Information status

A number of studies show that natural languages usually order information from given to new (Clark & Clark, 1977; Clark & Haviland, 1977; Halliday, 1967). Some researchers (e.g., Clark & Haviland, 1977) explain this preference with the listener's comprehension processes, i.e. ordering given information before new gives the listener time to search their memory for the antecedent of the given information before the new information appears. Ordering new information before given creates a memory problem, because the new information must be kept in the forefront all the while the listener waits for the given information with which it must be integrated (Clifton & Frazier, 2004). Others (e.g. Arnold et al., 2000; Wasow, 1997) emphasize the needs of the speaker as well, since "new information is less accessible than given information, and delaying the production of

new information while uttering given information gives the speaker additional time to access and plan how to express the new information" (Clifton & Frazier, 2004: 886).

A study by Narasimhan and Dimroth (2008), on the other hand, found that children acquiring German prefer new-to-old ordering of information. The procedure for the study consisted of the participants having been shown an object (e.g. an egg) in a transparent, round container. An experimenter who could not see the container asked the question: *was ist da drin?* "what's in there?" and the participant responded by describing the contents of the container. The participant was then shown two objects in a container, one of which consisted of the object that had been described before (e.g. an egg and a bed), and asked again to describe its contents. Three to five-year-old children consistently produced first the new and then the old referent in two-word utterances during the experiment. It may reflect the children's tendency to encode novel or changing elements in a situation first. This ordering changes to old-to-new in adulthood.

3. Acquisition of word order in English and Hungarian

This section reviews the relevant literature on the acquisition of word order in English, first from a nativist point of view and then from the usage-based aspect. It is followed by a report on children's preferences on the ordering of discourse-new and discourse-old elements in English. Finally, the existing literature on the acquisition of word order in Hungarian is reviewed.

3.1. Formalist approach in English

Neeleman and Weerman (1997) discuss the parameter setting approach to word order acquisition in their article, more specifically the OV/VO parameter. They wanted to see whether children make certain errors when acquiring phenomena related to the OV/VO parameter. If such errors are absent, the L1 data can be said to confirm to the proposed formulation of the parameter. In order to determine

this, they analyzed corpora from the CHILDES database. Many studies on first-language acquisition show that basic word order is acquired very early in English. In fact, as soon as order can be observed at the two-word stage, the occurrence of non-canonical structures is almost nonexistent. One of the predictions concerning word order is that once the OV/VO parameter is set, children will know whether the target language allows for scrambling or not. However, in order to be able to observe such phenomena, the child has to produce at least a verb, object, and adverbial in their utterance. Their findings support this prediction since none of the utterances violated case adjacency even when adverbials were added (e.g. *Didn't have a nap today*). Another prediction in the study is that Exceptional Case Marking (ECM) will appear with all classes of ECM verbs. This prediction is supported by the results (e.g. *Let me see*). The prediction concerning verb-particle constructions states that Case theory will trigger separation of the particle and the verb from the start. English children first place particles to the right of the object (e.g. *I wanna get the paint off*). Later, they acquire the verb-particle-object order (e.g. *A scraper gets off a little bit of sauce*). Neeleman and Weerman conclude their analysis on the L1 acquisition of English word order by claiming that the child language data agree with the parameter they proposed and basic word order can be observed from the very beginning of language production. The most important finding of the study is that certain mistakes are never made (e.g. case adjacency violation) because children acquire a language by setting parameters (the VO parameter in this case) and do not learn the grammar separately on an item-by-item basis (Neeleman & Weerman, 1997).

The corpora that the authors studied originally observed children's natural language production, therefore, some of the drawbacks of experimental research are avoided. The informants did not have to understand tasks or solve them, so the possibility of pleasing the adult investigators never occurred. For this reason, the data used in Neeleman and Weerman's (1997) study are assumed to be reliable, although the sample size is limited because they analyzed the corpora of only two informants. As this study shows, parameter setting does not allow much variation or certain mistakes that are possible in

data-driven experiments such as the ones discussed below, and therefore it can be considered strong evidence for innateness.

3.2. Usage-based approach in English

Akhtar (1999) admits that the parameter-setting approach has a basis since children order constituents accurately and exhibit sensitivity to the SVO order of English very early on, but she suggests that the results are due to the design of the experiments. She notes that previous studies on the acquisition of word order (both comprehension and production) employed only vocabulary familiar to the informants and it might be the explanation why the children exhibited a seemingly general understanding of word order. In fact, they might be only using the orders they have learnt for the familiar verbs. This perceived shortcoming of the experimental design prompted her to come up with a new method to gather new data on the matter. Her goal was to see whether children truly understand the use of word order and whether this understanding is general, therefore she based her experiment on novel verbs. So, if, for example, one invented a novel causative action and called it *dacking*, would children know what to do when asked to '*Make Big Bird dack Cookie Monster*'? Similarly, in producing sentences with the verb *to dack*, would they know that they must place any agent of the action before the verb, and any patient of the action after the verb? For this study, she applied the novel verb methodology with non-English orders. The informants were divided into three age groups: 2-, 3-, and 4-year-olds. Her purpose was to make a clear distinction between the two theories about language acquisition: the parameter setting and data-driven mechanisms of grammatical development. Supporters of the parameter setting approach claim that word order is "triggered by environmental input" (Akhtar, 1999: 343) and is not learnt because there are no natural languages in which some transitive verbs follow one ordering and some follow another. It means that children set the word order of their language early on and use only one with all transitive verbs. This is the reason why she chose the novel verb method with unfamiliar word orders for arguments.

Her study was followed by two others that used the methodology established in Akhtar (1999): novel verbs in utterances with non-English orders. Abbot-Smith, Lieven, and Tomasello (2001) based their study on the observation that when young children hear a novel verb used in one linguistic construction, they tend to continue using it in that, and only that, construction. Therefore, they tested 2- and 3-year-old children to see whether they correct the ungrammatical VS order with a novel verb and one argument to the canonical SV one. Matthews, Lieven, Theakston, and Tomasello (2005) developed their study to test children's production of word order. They used three sets of verbs with different frequencies (high, medium, and low) combined with the 'weird word order' design. The verb frequency manipulation method is based on the hypothesis that the more frequent and the earlier acquired a verb is, the less likely children will be to violate its argument structure by over-generalizing (Brooks et al., 1999). Matthews et al.'s (2005) hypothesis was that younger children (3-year-olds in their study) should be more likely to use the non-English word order modeled for lower frequency verbs than with more frequent verbs. On the other hand, older children (4-year-olds in their study) should be able to generalize from their more considerable experience and should be able to apply their knowledge of the SVO word order and correct any non-canonical word orders regardless of modeling.

Akhtar (1999) found that 2- and 3-year-olds produced non-English word orders with novel verbs half of the time, while the 4-year-olds mostly corrected the non-SVO orders to the default one. The first two groups consistently produced sentences like '*Big Bird the grapes gopping*' to indicate that Big Bird was performing an action on some grapes. However, this was not a tendency on the part of the children to please the adults, because control tests showed that they did not use non-English word orders with familiar verbs (e.g. '*Elmo the car pushing*'). These results confirm the initial hypothesis of the study that acquisition of word order is a gradual, data-driven process and is not due to strong parameter setting models. Abbot-Smith et al.'s (2001) results support Akhtar's (1999) findings for 3-year-olds and provide additional information on younger 2-year-olds, who corrected the VS order with novel verbs to SV 21% of the time, while 3-year-olds did so

66% of the time. Abbot-Smith and colleagues emphasize that, despite the results with the novel verbs, young 2-year-olds have some knowledge about the canonical English word order, since they corrected the familiar verb to the default order 72% of the time. Another finding is that they produced four times more SV utterances with the novel verbs than VS structures, which suggests that they developed some sense of the basic word order in English, even though half of the 2-year-old informants used the non-English word order productively. In Matthews et al.'s (2005) study 3-year-olds used the SOV order 47% of the time with low-frequency verbs, and never with high-frequency ones, i.e. they corrected the SOV ordering to SVO with those verbs. However, the children tended to omit one argument with low-frequency verbs and thus produce SV and VO orders to avoid using the SOV order. With high frequency verbs they reverted to the canonical order and mostly provided both subject and object arguments. Matthews and colleagues also found that 4-year-olds used the SVO order productively for higher frequency verbs, and they were always more likely to correct the sentences to SVO no matter the frequency of the verb used.

Overall, the findings do seem consistent with the notion that children's early grammatical development is data-driven. Akhtar (1999) claims that the observed differences in the ordering of arguments between the 2- and 4-year-olds determine the time period when knowledge of one's grammar is truly generalized. Although, even 2-year-olds are familiar with the SVO order, they are willing to produce other orderings as well mostly on a lexically specific basis (Tomasello et al., 1997). At around age 2, children start to develop sensitivity to transitive constructions in comprehension (Bavin & Growcott, 1999). By around 2;4, their knowledge is generalized enough to avoid using non-English word orders with novel verbs (in Abbot-Smith et al.'s (2001) study, they produced the non-canonical order less often than the canonical one), however, this knowledge is still lexically specific and relies on specific word order schemas in the production of utterances. From around age 2;8, they correct non-English word orders with novel verbs to SVO roughly half of the time (Akhtar, 1999) and use novel verbs in constructions they have never

heard before with approximately the same frequency (Tomasello, 2000). Matthews et al. (2005) argue that children will tend to correct non-English word orders to the canonical one in constructions with familiar and well-used lexical items or when they observe similarities between structures (e.g. transitives) and can apply this knowledge to develop grammatical schemas. By ages 4 and 5, children show that they can generate creative utterances from verb general schemas (Pinker, Lebeaux, & Frost, 1987). Theories that propose a universal, innate component to word order acquisition, such as the Head Direction Parameter (Christophe et al., 2003), should predict a more sudden onset in the ability to use word order fully productively with all lexical items that have been successfully categorized. The results of these studies (Akhtar, 1999; Abbot-Smith et al., 2001; Matthews et al., 2005) could be potentially explained in the parameter-setting framework, however it would still need an additional lexical learning component that the informants demonstrated, and that would in turn make the fundamental innate element of the theory redundant.

In her study, Akhtar designed her tests around three word orders: SVO, SOV, and VSO. However, the other three (VOS, OVS, and OSV) were not included. Her reasoning was that "of the six possible orders, these three are by far the most frequently found in the world's languages (Tomlin, 1986). They are also the three used by Bates et al. (1984) in their examination of Italian and American children's comprehension of word order (with familiar verbs)" (Akhtar, 1999: 343). The common factor about them is that they are all subject-first sentences in which the subject is always the agent. The informants in all age groups were more willing to produce sentences in which the subject remained in the canonical sentence-initial position and its function as the agent remained transparent. According to her results, the children used the VSO order the least, although they still used it somewhat. Based on this, it is also possible that they simultaneously generalize their knowledge on the position of the verb and the agent in the sentence. This could have been tested with the inclusion of non-subject-first orderings to see if they are more likely to put the subject/agent before the object regardless of the position of the verb. The best choice for testing would be the OVS order in which the verb

is still in sentence-medial position, but the arguments are switched. The children should be less likely to use it than even the VSO one, because it is not a subject-first ordering even though the verb is in the right place. If the actions denoted by these sentences were modeled properly, the informants would still know which argument is the agent, and the lack of inflections would not be an issue.

A major shortcoming evident in all three studies is that the informants, regardless of age, produced non-English word orders at extremely low rates. It is likely that when the children matched the modeled non-canonical order, they simply copied the investigators (as Matthews et al. (2005) point out in their study). In Matthews et al.'s (2005) study, 3-year-olds produced 'weird word orders' with high frequency verbs, which undermines the authors' hypothesis about frequency effects. This age group supposedly also has relatively well-developed grammatical representations, but they were still willing to use non-canonical orders with verbs that they regularly heard and used in the SVO order. The logical explanation is that they wanted to please the adult investigators. Another notable observation is that whenever the children corrected the word order, they did so to the default SVO every time, which suggests that they are aware of the correct order in their native language. Also, not even the 2-year-olds ever "corrected" the SVO order to something other, even though their knowledge on word order is supposedly still not generalized enough (according to Akhtar (1999) and Abbot-Smith et al. (2001)). Finally, another explanation for the children's production of non-English word orders might be that they simply could not infer the investigator's purpose, i.e. the informants are expected to correct to SVO (Franck & Lassotta, 2012). The data from these three studies (Akhtar, 1999; Abbot-Smith et al., 2001; Matthews et al., 2005) actually support the parameter setting hypothesis for several reasons (Franck & Lassotta, 2012). Informants in all age groups produced the modeled ordering at a higher rate when it was grammatical, they corrected the ungrammatical orderings only, furthermore, they corrected to the default SVO, and finally they productively used grammatical elements like pronouns only in grammatical utterances. Franck and Lassotta (2012) argue that it seems hard to account for this set of results without assuming that the young

child already has an abstract representation of the word order of their language.

3.3. Ordering of elements based on their information status in English

Baker and Greenfield (1988) claim that children have a capacity to differentiate new or changing information from the time they are young infants. Both naturalistic and experimental research has been conducted to observe children's language development at the one-word stage, and the results indicate that they will verbally express the most informative element of the situation at hand, using language to reduce uncertainty (e.g. Bates, 1976). At this stage children attempt to be as informative as possible by expressing the novel or changing element and they never express constant or unchanged elements, even though the words of these referents are already part of their vocabulary. The topic-comment distinction is related to the informativeness principle. The topic is the part of the sentence which constitutes what the speaker is talking about, whereas the comment provides new information about the topic. Bates and McWhinney (1979) believe that, at the one-word stage, the child expresses comments only, and Greenfield's (1973) data show that the child verbalizes new information. Therefore, at the one-word stage, comments can be viewed as new information.

Baker and Greenfield (1988) hypothesize that, even though word order may be fixed for English speaking children during the two-word stage, informativeness or newness would continue to determine their word order, that is, the two words the child does verbally express would be the two most informative elements. Baker and Greenfield conducted a longitudinal study to address the questions of how the expression of new information correlates with the fixed order of English: whether children would express new information first in two-word utterances regardless of English word order or they would express it in single-word utterances. Their results clearly indicate that children tend to use one-word utterances at the two-word stage to express new or uncertain information. When children start to produce

multi-word utterances, their single-word utterances retain their function as expressions of new information just like at the previous stage.

Baker and Greenfield divided the children's two-word utterances into topic-comment, comment-topic, and comment-comment categories. Topic is defined as what the speaker is talking about, but it does not have to be old information. The comment adds new information about the topic, but once it has exceeded the length of one word, it can itself be composed of new and old elements. Interestingly, there were no topic-comment structures at all in the gathered data, the comment always preceded the topic. There was a need for a third category, comment-comment (or expanded comment), when most of the two-word utterances did not fit into the first two categories. Baker and Greenfield labeled utterances as comment-comment when the "unspoken topic" (the object or person the child was commenting on but not verbalizing) was easily seen. In every case of the expanded comment, the unspoken topic is old or uninformative and it denoted the children themselves or an object in their hands. On the other hand, the explicit topics always referred to something (an object) not in the possession of the child speaker. Overall, topics are verbalized when they are newer information. There was a strong tendency in both comment-topic and comment-comment utterances for the first word to contain new information. It clearly means that children prefer to order information from new to old.

The limitation of the study is that it did not focus on natural speech but the investigators tried to elicit spontaneous verbalization of scripted events without prompting, i.e. the children had to spontaneously describe the actions they were doing during the experiments without the investigators labeling referents or actions. During the tests, the participants always adhered to the default word order of English in multi-word utterances, therefore the question remains if they would actually keep to this tendency of ordering new information first in naturally occurring multi-word utterances. The answer is probably no, because by the time children produce multi-word utterances, their language strongly resembles adult language, which always orders information from given to new (Narasimhan & Dimroth, 2008). However, it is still significant that in single- and two-

word utterances, children put new information first, since it is a phenomenon observed cross-linguistically regardless of the default word order of the languages studied.

3.4. Hungarian word order and its acquisition

Hungarian is often referred to as a "free-word-order" language. It is important to note that the rich inflectional system of Hungarian that allows the flexibility of word order also enables the pro-drop parameter, i.e. Hungarian utterances can include null-subjects (É. Kiss, 2002). Hungarian displays a range of orders like the unmarked declarative SVO and others that involve leftward movement. In fact, the unmarked declarative orders are only a portion of the used utterances (Puskás, 2000). É. Kiss (2002) states that this description of Hungarian as a free word-order language stems from the fact that the grammatical functions of arguments are not linked to invariant structural positions in the sentence. It means that "a transitive verb and its two arguments, e.g. *keresi* 'seeks' *János* 'John' *Marit* 'MaryACC' can form a sentence in any of the theoretically possible SVO, SOV, OVS, OSV, VSO, and VOS combinations" (É. Kiss, 2002: 2):

(1) János keresi Marit. Marit János keresi.
János Marit keresi. Keresi János Marit.
Marit keresi János. Keresi Marit János.
(É. Kiss 2002: 2)

If observed more closely, it becomes clear that the major sentence constituents are constrained very strictly. However, their order is determined by their logical functions (e.g. topic, focus, etc.) and not their grammatical roles (e.g. subject, object, etc.) as in non-free-word-order languages, such as English or French (É. Kiss, 2002). In Hungarian, the logical elements of an utterance are positioned in the left-periphery of the clause (the CP level), and these constituents are preposed by leftward movement (Puskás, 2000). In Hungarian, sentences can be divided into topics and predicates. É. Kiss (2002) states that the topic is not expressed by a particular grammatical

function (subject or object). However, subjects tend to be in the topic position more often than objects because one usually describes something from a human perspective. Since subjects tend to have the [+human] feature more frequently than objects, they occur more as topics. On the other hand, when a verb has a [–human] subject and a [+human] accusative or oblique complement, the argument with the [+human] feature becomes the topic (2a, b). Furthermore, when the possessor is the only human involved in an action or state, it is usually topicalized (2c) (É. Kiss, 2002).

(2) a. [$_{\text{Topic}}$ Jánost] [$_{\text{Predicate}}$ elütötte egy autó]
John.Acc hit a car
'A car hit John. [John was hit by a car.]'
b. [$_{\text{Topic}}$ Jánosból] [$_{\text{Predicate}}$ hiányzik a becsület]
from.John is.missing the honesty
'Honesty is missing from John. [John lacks honesty.]'
c. [$_{\text{Topic}}$ Jánosnak] [$_{\text{Predicate}}$ összetörték az autóját]
John.Dat they.broke the car.Poss.Acc
'They broke John's car. [John had his car broken.]'
(É. Kiss, 2002: 9)

É. Kiss (2002) states that in Hungarian, the focus of a sentence is internal to the predicate phrase and expresses exhaustive identification from among a set of alternatives. "The focus represents a proper subset of the set of contextually or situationally given referents for which the predicate phrase can potentially hold; it is identified as the exhaustive subset of this set for which the predicate phrase holds" (É. Kiss, 2002: 78). The focus position immediately precedes the verb and it splits up the verb from its verbal modifier (VM). This is a reliable method to determine whether an element preceding the verb is a topic or a focus, because topics do not have this ability to control the behaviour of verbal modifiers, i.e. prefixes.

(3) a. [$_{\text{TopP}}$ Pétert [$_{\text{Predicate}}$ [$_{\text{Focus}}$ JÁNOS] mutatta be Marinak]]
Peter.Acc John introduced VM Mary-to
'As for Peter it was John who introduced him to Mary.'

b. [$_{TopP}$ János [$_{Predicate}$ [$_{Focus}$ PÉTERT] mutatta be Marinak]]
'As for John, it was Peter that he introduced to Mary.'
c. [$_{TopP}$ Pétert [$_{Predicate}$ [$_{Focus}$ MARINAK] mutatta be János]]
'As for Peter, it was to Mary that John introduced him.'
(É. Kiss, 2002: 78)

When it comes to the basic word order of Hungarian, some claim that it used to be SOV based on typological evidence since Proto-Uralic is presumed to have had SOV default ordering (Sipőcz, 2006). However, during the development of Hungarian in the Middle Ages, both SOV and SVO were documented in equal measures. SOV was and is still used with indefinite objects, while SVO with definite objects (Korompay, 2006). Therefore, it can be argued that Hungarian basic word order is binary with two default orders: SVO and SOV.

Several studies have been conducted on children's word order in Hungarian. One of them is MacWhinney, Pléh and Bates (1985), which examines the development of the comprehension of simple sentences in Hungarian. They state that the unmarked or basic order is SVO when the object is definite and SOV when the object is indefinite without an article. Another important thing is that the variability of word order is possible because of the uniformity of case marking on the object of the verb. They investigated children's comprehension regarding the agent of sentences with different word orders (all possible in Hungarian). They concluded that the children mostly relied on case marking to determine the object of the sentences and then to identify the agent of the action. The age of the participants ranged from 3;1 to 5;7, and shows that even at 3 years of age, children are familiar with the word order possibilities of Hungarian, and can comprehend the different roles in a sentence very well.

A study conducted on Hungarian preschool children tested their ability to interpret sentences by enacting them with toys (Pléh, 1981). It found that children usually followed the principle that the first noun in the utterance is the agent and their performance was significantly better with sentences of SVO and SOV word orders (where the agent and the topic coincided) than with OVS and OSV orderings. These results suggest that children can more easily identify the topic of the

sentence as the agent if it is in a subject-first utterance than if it is in an object-first utterance.

MacWhinney (1975) examined the role of pragmatic patterns in child syntax in Hungarian. He found that there is a short period, early in Hungarian acquisition, when verbs occur more often initially then finally. This tendency toward verb-fronting exists despite the fact that Hungarian word order is basically Agent-Object-Action (SOV), according to him. It is a result of the fact that children put new, more interesting things first in a sentence, even if the child's language does not allow it; as he mentions it in his review of the literature concerning other languages (e.g. Braine, 1963). Another conclusion is that expressive focusing, whether marked lexically, syntactically, or intonationally, emerges at least as early as logical focusing or topicalization. At the age 2;2 to 2;5, the informants produced the adultlike unmarked word order, where the logical focus comes first (Agent), followed by a pause and the expressive focus, which receives primary stress (Object), and finally the verb is in last place.

(4) telefon kér
telephone want
'I want the telephone'

In this example, the child puts the important information (according to him) in the position of the expressive focus (*telefon* 'telephone') and gives it primary stress.

4. Methodology

Three studies were conducted on the acquisition of Hungarian word order and the ordering of arguments in two- and three-constituent utterances based on their information status (discourse-new or discourse-old).

4.1. Study 1

Based on previous studies, the following research questions can be posed:

1. Do Hungarian children prefer the default word order of the language and later acquire the variants?

2. How do children assign arguments to new and old referents in two-constituent sentences?

The initial hypotheses are that children acquiring Hungarian use different kinds of word order to mark pragmatic information even when they just start constructing sentences; and that children prefer the SV and OV ordering to refer to new information, and the VS and VO ordering to refer to old information.

In order to address the questions just raised, data from the CHILDES database were retrieved (MacWhinney, 1975; MacWhinney & Bates, 1978; Bodor, 2004). The data were gathered from thirteen informants between the ages 2;0 and 4;1. Since the informants were part of several different studies, the data are not consistent on all accounts, and the names and genders of the informants are not displayed everywhere. Because of this, the present study omits the names and genders of the children. The informants were divided into three groups based on age. The first group centres around age 2 (age range: 2;0-2;3), the second one around age 3 (age range: 2;8-3;2), and the third one around age 4 (age range: 3;7-4;1). There were four children in the first two groups each and five children in the third group. Three corpora were analysed for this study, one of which observed spontaneous speech (Bodor, 2004) and the other two required the informants to narrate the events seen in several pictures (MacWhinney, 1975; MacWhinney & Bates, 1978).

Both two-word and multi-word utterances were considered which contained a subject and/or an object and a (transitive) verb. Four types of word orders for two-word utterances (SV, VS, VO, and OV) and six types of word orders for multi-word utterances (SVO, SOV, VSO, VOS, OVS, and OSV) were collected. The data were analysed , and the frequency of the word order types was calculated for each age group. The significance of the results was calculated using the chi-

square test. Some of the utterances found in the corpus are the following:

(5) SV anyu integet
mommy.Nom wave.3sg.pres
'Mommy is waving.'

(6) VS alszik a baba
sleep.3sg.pres the baby.Nom
'The baby is sleeping.'

(7) VO dobják a virágot
throw.3pl.pres the flower.Acc
'They are throwing the flower.'

(8) OV a virágot eszi
the flower.Acc eat.3sg.pres
'It is eating the flower.'

(9) SVO nyuszika adja a virágot
bunny.Nom give.3sg.pres the flower.Acc
'The bunny is giving the flower.'

(10) SOV nyuszi füvet rág
bunny.Nom grass.Acc chew.3sg.pres
'The bunny is chewing grass.'

(11) VSO elvette a Zoli vonatot
take.3sg.past the Zoli.Nom train.Acc
'Zoli took the train.'

(12) VOS megeszi a banánt a mókus
eat.3sg.pres the banana.Acc the squirrel.Nom
'The squirrel is eating the banana.'

(13) OVS fagylaltot eszik a kislány
ice cream.Acc eat.3sg.pres the girl.Nom
'The girl is eating ice cream.'

(14) OSV ezt te csináltad
this.Acc you.Nom do.2sg.past
'You did this.'

The utterances in the corpus are generally well-formed and are judged as pragmatically appropriate by a native speaker.

4.2. Study 2

The purpose of this study is to observe the word order acquisition as a continuous process and not divided into age groups like in Study 1. The data were retrieved from the Réger corpus of the CHILDES database, which studied the natural and spontaneous speech of a single informant.[1] The informant is a Hungarian native speaker who was recorded between the ages of 1;11 and 2;11. For the purpose of this study, all two- and three-constituent utterances were gathered from the entire corpus.

4.3. Study 3

The aim of this study was to see if there are any correspondences between word order types and the ordering of information. The initial hypothesis is that the subject precedes the object when its referent is new in the discourse and follows it when its referent is old (and the object's referent is new). That is, the SVO, SOV, and VSO orderings are used when the subject's referent is new in the discourse and the object's is old, while the VOS, OVS, and OSV word orders are used when the object's referent is new and the subject's is old. The ordering of new and old information was observed in the utterances of ten 3-year-old and ten 4-year-old informants. The data were gathered from various corpora within the CHILDES database (MacWhinney, 1975; MacWhinney & Bates, 1978; Bodor, 2004). Only three-constituent utterances were examined that contain both a subject and an object along with the transitive verb.

[1] http://childes.talkbank.org/browser/index.php?url=Other/Hungarian/Reger/

5. Results

5.1. Study 1

Table 1 includes all the information on the frequency of sentences by age group and word order type. The informants produced significantly more two-word utterances (N=306) than multi-word ones (N=79). The number of multi-word utterances is statistically insignificant compared to the high number of two-word utterances. Therefore, significant differences could not be calculated to see the preferences of children.

Table 1. Frequency of all types of word order

		Age					
		2;0-2;3		2;8-3;2		3;7-4;1	
Word order	**Total**	N	%	N	%	N	%
SV	124	41	33.61	37	29.13	46	33.82
VS	52	20	16.39	15	11.81	17	12.5
VO	96	40	32.79	36	28.35	20	14.71
OV	34	14	11.47	16	12.6	4	2.94
SVO	48	4	3.28	11	8.66	33	24.26
SOV	20	0	-	10	7.87	10	7.35
VSO	4	3	2.46	0	-	1	0.73
VOS	1	0	-	0	-	1	0.73
OVS	4	0	-	0	-	4	2.94
OSV	2	0	-	2	1.57	0	-
Total	385	122		127		136	

Table 2 includes information on the use of word order types within each age group. The 2- and 3-year-olds produced twice as many SV utterances than VS ones, while the 4-year-olds produced almost three times as many. As for the object-verb orderings, the 2- and 3-year-olds uttered twice as many VO sentences than OV ones, whereas the 4-year-olds uttered five times as many. This is not significant, because the 4-year-olds uttered verb-object combinations in a disproportionately low number.

Table 2. Frequency of two-constituent word orders in each age group (p=0.04)

		Age					
		2;0-2;3		2;8-3;2		3;7-4;1	
Word order	**Total**	N	%	N	%	N	%
SV	124	41	35.65	37	35.58	46	52.87
VS	52	20	17.39	15	14.42	17	19.54
VO	96	40	34.78	36	34.62	20	22.99
OV	34	14	12.17	16	15.38	4	4.76
Total	306	115		104		87	

Table 3 includes the new-old ordering of information in two-constituent utterances, i.e. it shows whether the subject and the object refer to a new or old referent in SV, VS, VO, and OV word order utterances. The differences between the new and old referents for each ordering and age group are not statistically significant with a p=0.07 value.

Table 3. The distribution of new and old information in two-constituent utterances (p=0.07)

	Age											
	2;0-2;3				2;8-3;2				3;7-4;1			
	New		Old		New		Old		New		Old	
Word order	N	%	N	%	N	%	N	%	N	%	N	%
SV	5	12.19	36	87.80	8	21.62	29	78.38	16	47.06	18	52.94
VS	1	5	19	95	8	53.33	7	46.67	2	14.29	12	85.71
VO	9	22.5	31	77.5	9	25	27	75	17	50	17	50
OV	5	35.71	9	64.29	6	37.5	10	62.5	2	40	3	60
Total	20	17.39	95	82.61	31	29.81	73	70.19	37	42.53	50	57.47
	115				104				87			

Table 4 includes the information on the order of new and old referents in three-constituent utterances. The possible combinations are the following: both the first and the second argument are new; the first argument is new, the second one is old; the first one is old, the second one is new; and both arguments are old in the discourse. In this table, the word order determines the information status of the arguments. So,

if the word order is SVO in the new-old category, then the subject is new while the object is old. On the other hand, if the word order is OVS in the new-old category, then the object is new and the subject is old.

Table 4. New-old information ordering in three-constituent utterances

	Age											
	2;0-2;3				2;8-3;2				3;7-4;1			
WO	new-new	new-old	old-new	old-old	new-new	new-old	old-new	old-old	new-new	new-old	old-new	old-old
SVO	-	-	-	4	1	-	3	7	7	2	10	14
SOV	-	-	-	-	3	2	5	-	5	4	1	-
VSO	-	-	-	3	-	-	-	-	-	-	-	1
VOS	-	-	-	-	-	-	-	-	1	-	-	-
OVS	-	-	-	-	-	-	-	-	-	3	-	1
OSV	-	-	-	-	-	-	-	2	-	-	-	-

The results of the study support the initial hypothesis that Hungarian children use different kinds of word order to mark pragmatic information even when they just start constructing sentences. The 2-, 3- and 4-year-old informants had significant preferences when it came to the production of word order variants in two-constituent utterances. They significantly favoured the SV and VO orderings. This means that they are aware of the functions of the orderings and use them accordingly, i.e. their pragmatic competence has developed simultaneously with their morphosyntactic competence. This outcome is similar to studies conducted on Russian, German, and Tamil children (Dyakonova, 2004; Narasimhan & Dimroth, 2008 and Sarma, 2003 respectively), and support the theories by Snyder and Bar-Shalom (1998) and Avrutin and Brun (2001) that children do not only use the default word order of a language but are aware of the pragmatics of their language as well.

The overall results support the fact that three-constituent utterances are produced more in later stages of language acquisition, from ages 3 and 4, and as the children grow older and the production of three-constituent utterances increases, the frequency of two-constituent

utterances decreases (from 115 utterances at age 2 to 87 utterances at age 4). As for the frequency of each word order type, children used more SVO and SOV orderings (N=68) than all other kinds of three-constituent orderings (N=11) by a large margin. It confirms previous theories that default word order in Hungarian is SVO when the object is definite and SOV when the object is indefinite without an article (MacWhinney & Pléh, 1997; Korompay, 2006).

When the frequency of word order types was considered within each age group, there were notable differences between the 2- and 3-year-olds and the 4-year-olds. Namely, the first two groups produced utterances at an almost identical rate, i.e. around 35% for SV and VO orderings and around 15% for VS and OV orderings. However, 4-year-olds produced a disproportionally large number of SV orderings (46 out of 87: a 52% ratio), and a very small number of OV orderings (4 out 87: a 5% ratio). The frequency of VS and VO orderings was around 20%. It is possible that they tend to express all the referents linguistically and do not use as many ellipses. Notice that they produce the highest number of three-constituent utterances, which means that they tend to include the agent in the form of the subject in their utterances and they do not produce as many object-verb combinations with a null subject.

Another analysis of the corpus was conducted to shed light on the children's preferences when ordering new and old information. Both MacWhinney (1975) and Narasimhan and Dimroth (2008) point out that it is a tendency of both Hungarian and German children to use the new-old ordering, and put new information first followed by the old information. This analysis could not show a clear-cut answer for this question, since there were not enough data to get significant results or see tendencies. It might be that children prefer the SV ordering when the referent of the subject is new in the discourse since there are slightly more new referents in the SV sentences than in the VS ones, but further testing is still needed to confirm this. Although the data on the ordering of arguments based on the newness and oldness of their referents are not enough to do a thorough analysis in three-constituent utterances, there seems to be a slight tendency in SVO and SOV sentences, for which categories there is the most information. In all age

groups, SVO is used the most when the referents of both arguments are old, and slightly less when the referent of the subject is old, and the referent of the object is new. On the other hand, the SOV order seems to be applied in cases when the subject referent is new, and the object referent is either new or old. For the other word order types there are not enough data to even observe tendencies.

This might be the reason for the not statistically significant results, since the tendencies are there, and with more data they might become significant. Both the number of informants and utterances for each age group should be increased. Another issue is that the age range should be extended from around age 1;6 to 5;0, from the time children start uttering two-word sentences consistently to the time they produce multi-word ones effortlessly.

5.2. Study 2

The table in Appendix A includes the data on the word order acquisition process of a Hungarian native speaker. It seems that all two-constituent utterances are present from the beginning of this corpus. There is no evidence that could answer the question which ordering(s) occur(s) first. However, if it is assumed that frequency correlates with age of acquisition, it can be argued that due to the high frequency of SV orders, it might be the first order to ever occur, but it cannot be determined in this study. On the other hand, the higher number of VO orders might indicate that it occurs after the SV chronologically and before the other two (VS and OV). When it comes to the three-constituent ordering, they first appear at around 2;3. As expected, the SVO and SOV have a relative high frequency (N_{SVO}=6 and N_{SOV}=3) compared to the rest. Interestingly, the word orders that have the lowest frequencies overall, OSV and VSO (N=1 each), occur at this age only and not once later. It seems that true variation in word order starts at this age as well. Since the first appearance of the default orders, other orders are represented as well, albeit to varying extent. On the basis of these data it can be argued that VSO occurs before OVS, however, there is no clear evidence to support this difference, and further testing is needed.

The results confirm the previous findings regarding the frequency of two-constituent utterances. Overall, the informant produced around twice as many SV and VO orderings as VS and OV ones. He started producing three-constituent utterances at the age of 2;3 with a high ratio of SVO and SOV orderings. They occur 26 (5.76%) and 24 (5.32%) times respectively in the whole corpus, while the other four word order types occur only one to three times (0.22 – 0.67%), which is a very low frequency compared to the total number of utterances, N_0=451. Although the corpus includes information on the child only until age 3, he managed to produce every type of three-constituent word order at least once. This confirms the initial hypothesis from the pilot study that children use every type of word order to convey pragmatic information even when they just start constructing two- and three-constituent utterances. It also confirms the findings of MacWhinney and Pléh (1997), who conlcuded that the default word order in Hungarian for three-constituent utterances is SVO when the object is definite and SOV when the object is indefinite without an article. In (15) and (16), the word order of the sentences is SVO and the object of both sentences is definite. In (17) and (18) the conjugation is subjective, therefore the object is indefinite, and the default word order is SOV for both utterances.

(15) SVO doktor néni meggyóttya apu fogát
doctor.Fem.Nom heal.pres.3sg dad tooth.Acc
'The doctor heals dad's tooth'

(16) én hozom az enyémet
I.Nom bring.pres.1sg the mine.Acc
'I'm bringing mine'

(17) SOV én tojást kéjek
I.Aom egg.Acc want.pres.1sg
'I want an egg'

(18) én kettő anyukát szejetnék venni
I.Nom two mother.Acc wish.pres.1sg buy.inf
'I would like to buy two mothers'

The number of three-constituent utterances is very low. After the default word orders (SVO and SOV), both VSO and OVS occur three times each (0.67%), while VOS and OSV occur only once each in the whole corpus (0.22%). The explanation might be that the subject-first ordering (SVO, SOV, and VSO) is preferred to the object-first one (VOS, OVS, and OSV). The exception to this preference might be when the object is in focus position (OVS) because in that case it occurs at the same frequency as the subject-first VSO.

(19) OSV ötöt én tajtom
five.Acc I.Nom hold.pres.1sg
'I am holding (the number) five (card)'

(20) VOS megnézte lábomat dottó bácsi [=doktor bácsi]
prefix-look.past.3sg leg.poss.Acc doctor.Nom
'The doctor has looked at my leg'

(21) VSO nézi a maci a ájjatokat [=állatokat]
look.pres.3sg the bear.Nom the animal.pl.Acc
'The (teddy) bear is looking at the animals'

(22) OVS anyukát fogok én adni
mother.Acc will.1sg I.Nom give.inf
'I will give a mother'

However, the occurrence of the OSV order is very low (only one instance in this corpus). In an OSV utterance the object is in topic position with the subject as the focus. The explanation might be that the topics is usually the subject or an arguments that has a [+human] feature, however utterances that do not have human subjects but have accusatives or oblique complements (e.g. possessive) with this feature are rather rare (É. Kiss, 2002). So, if there is a subject in the sentence, there is a greater chance for it to have the [+human] feature than the object. The other low frequency ordering is VOS, which is said to be the most marked word order and, therefore, farthest from the prototype (MacWhinney & Pléh, 1997). This condition might not have allowed it to occur naturally in the corpus many times.

If we compare these results with the numbers in Table 1, we can see that these observations hold true through all age groups. The default word orders (SVO and SOV) have the highest frequency, they are used 48 (12.47%) and 20 (5.19%) times, respectively, by all age groups (N_0=385). The 2-year-old age group that most corresponds to the age of the informant from this study used only the SVO order and only four times. The other three-constituent word orders in Study 1 have a similarly low frequency as in Study 2. The third subject-first word order (VSO) occurs three times (0.67%) in this study and four times (1.04%) in Study 1. Out of those four occurrences, three are produced by the 2-year-old age group. Aside from the default word orders (SVO and SOV) this has the highest frequency compared to object-first orderings. However, the object-first OVS ordering with the object in focus position is proven to be an exception even in this comparison. In Study 1 it occurs 4 times (1.04%), which is the same frequency as the VSO order, while in this study it occurs 3 times (0.67%), which is again the same as the VSO order. The other two object-first orderings OSV and VOS occur only once or twice in both studies. In Study 1, they are produced by older children (3- and 4-year-olds), so it can be argued that these rarer orderings gain frequency at later ages (older than age 4), but do not reach default word order levels.

The major drawback of this study is that the corpus used contains data on the informant only from 1;11 to 2;11 of age and there were not many possibilities to examine his production of three-constituent utterances in more detail. For this purpose a new corpus should be compiled that follows one or multiple informants to at least 4 or 5 years of age to more thoroughly investigate the acquisition of the word order of three-constituent utterances. Another shortcoming of the corpus is the fact that originally it was used for a case study, therefore it contains data only about one informant, which is insufficient to make true generalizations.

5.3. Study 3

The table in Appendix B includes the data on the ordering of information based on their newness and oldness, according to word

order type and per age. The possible combinations are the following: both the first and the second argument are new; the first argument is new, the second one is old; the first one is old, the second one is new; and both arguments are old in the discourse.

Overall, subject-first orderings have a very high frequency compared to object-first orders. The production of SVO is the largest (N_{SVO}=106, 57.61%), while the other two are considerably less frequent (N_{SOV}=23, 12.5%; N_{VSO}=26, 14.13%). VOS (N_{VOS}=16, 8.7%) and OVS (N_{OVS}=11, 5.98%) have a relatively higher frequency than OSV (N_{OSV}=2, 1.09%) but much lower than all the subject-first orderings. VOS has a similar frequency as VSO. It is not a coincidence since these topicless orderings are usually used to describe events (É. Kiss, 2002), and the original goal of parts of the corpora were to record narratives (children describing pictures with some kind of actions depicted on them). In the OVS order, the object is in the focus position, so it is used to mark pragmatic meaning, which might be the reason for its frequency.

Table 5 includes only the information about the new-old and old-new orderings per word order type in both age groups. The goal is to see how children order arguments based on their information status (i.e. whether they are old or new in the discourse). The informants produced slightly more utterances in which the information status of the referents is from the new to the old order, however the results are not statistically significant ($p>0.05$). Overall, more than half of the utterances (57% for 3-year-olds and 53% for 4-year-olds) contain new information first and old information follows it.

Table 5. Frequency of new-old and old-new ordering of information per word order type (p=0.7)

		Ordering of information									
		3-year-olds					**4-year-olds**				
			new-old		**old-new**			**new-old**		**old-new**	
Word order	**N_0**	**N_3**	**N**	**%**	**N**	**%**	**N_4**	**N**	**%**	**N**	**%**
SVO	42	19	11	57.89	8	42.11	23	9	39.13	14	60.87
SOV	12	7	2	28.57	5	71.43	5	4	80	1	20
VSO	10	10	6	60	4	40	0	0	-	0	-
VOS	5	4	3	75	1	25	1	1	100	0	-
OVS	5	2	2	100	0	-	3	3	100	0	-
OSV	0	0	0	-	0	-	0	0	-	0	-
Total	74	42	24	57.14	18	42.86	32	17	53.12	15	46.87

Although the results are not statistically significant, the visible tendencies are similar to previous findings on this matter (Narasimhan & Dimroth, 2008; MacWhinney & Pléh, 1997). As for the distribution of word order types, subject-first sentences generally have a higher frequency in the new-old ordering type except for the SVO order in the 4-year-old group (only 40%) and the SOV in the 3-year-old group (approximately 30%). These differences are not statistically significant (p=0.2), so it is most probably due to the small amount of data. Examples (23) – (25) contain subject-first utterances with new to old ordering:

(23) SVO [*CONTEXT: a kocka kergetette a pipát*
the dice.Nom chase.past.3sg the pipe.Acc
'The dice chased the pipe']
a kutya pedig kergetette a kockát
the dog.Nom and chase.past.3sg the dice.Acc
'And the DOG chased the dice'

(24) SOV [*CONTEXT: nyuszi füvet rág*
bunny.Nom grass.Acc chew.pres.3sg
'The bunny is chewing grass']
majom füvet rág
monkey.Nom grass.Acc chew.pres.3sg

‘The monkey is chewing grass’

(25) VSO [*CONTEXT: az meg nem döntötte föl a labdát*
that.Nom and not topple.past.3sg.VM the ball.Acc
‘And that hasn’t toppled the ball’]
odaadja a bácsi a labdát
VM.give.pres.3sg the man.Nom the ball.Acc
‘The man is giving the ball’

Examples (26) – (28) contain subject-first utterances with old to new ordering:

(26) SVO [*CONTEXT: nézi hogy megy a karácsonyfa*
watch.pres.3sg as go.pres.3sg the Christmas tree.Nom
‘(Someone) is watching as the Christmas tree walks’]
karácsonyfa kergeti a pingvint
Christmas tree.Nom chase.pres.3sg the penguin.Acc
‘The Christmas tree is chasing the penguin’

(27) SOV [*CONTEXT: first sentence of discourse*]
én hógolyót csinálok
I.Nom snowball.Acc make.pres.1sg
‘I’m making a snowball’

(28) VSO [*CONTEXT: a zebra kergette a rozmárt*
the zebra.Nom chase.past.3sg the walrus.Acc
‘The zebra chased the walrus’]
betolta a rozmár azt a fát
push-in.past.3sg the walrus.Nom that.Acc the tree.Acc
‘The walrus pushed in the tree’

Object-first sentences are generally ordered from new to old with only one counterexample for VOS in the 3-year-old group. Examples (29) and (30) contain object-first utterances with new to old ordering, while example (31) is the only instance of old to new ordering:

(29) VOS [*CONTEXT: a boci megütötte az asztalt*
the cow.Nom VM.hit.past.3sg the table.Acc
'The cow has hit the table']
kergeti a zebrát a boci
chase.pres.3sg the zebra.Acc the cow.Nom
'The cow is chasing the zebra'

(30) OVS [CONTEXT: *kislány eszi a kekszet*
girl.Nom eat.pres.3sg the cookie.Acc
'The girl is eating the cookie']
almát eszi a kislány
apple.Acc eat.pres.3sg the girl.Nom
'The girl is eating the apple'

(31) VOS [*CONTEXT: a szék a karácsonyfát lökte el*
the chair.Nom the Christmas tree.Acc push.past.3sg.VM
'The chair pushed away the Christmas tree']
kitolta a széket az alma
VM.push.past.3sg the chair.Acc the apple.Nom
'The apple pushed out the chair'

If we consider these tendencies, the initial hypothesis of this study should be confirmed since in the SVO, SOV, and VSO utterances the subject's referent is mostly new, while in the VOS, OVS, and OSV ones the object's referent is new in the discourse. However with statistically not significant results this confirmation is not possible. As has been pointed out in the pilot study as well, these results cannot be taken at face value to claim that children do not display any preferences when it comes to ordering of arguments based on their information status. Since the responses in these corpora were not controlled for discourse functions, their analysis is rather problematic. Further research is needed on a larger corpus with a wider age range (3-6 years of age) and controlled testing to get statistically significant results and confirm or reject the initial hypothesis of this study.

6. General discussion

It can be seen in the reviewed studies that English children mostly adhere to the default SVO order even at the early stages of sentence production (age 2), and even more at later stages (ages 3-4). The variation that was observed in the studies within the usage-based framework was negligible and it is not considered significant. It is rather straightforward why children behave this way, since English word order is used to encode the relation between sentence constituents, and if a non-canonical order is uttered the meaning of the sentence becomes unclear. Essentially, children acquiring English follow a strict schedule when acquiring word order. At the two-word stage, they produce SV and VO orderings, while from the multi-word stage, they use the SVO order. In some cases, a slight deviation from the default order can be observed, however, it rapidly decreases with age, and at around age 4, these tendencies generally stop. The results of the reviewed study regarding the information status of arguments in English seem to support Narasimhan and Dimroth's (2008) study, which found that children prefer to order sentence constituents from new to old information in the discourse. Essentially, they first mention the constituent whose referent is new in the discourse, and either omit the constituent referring to old information or have it follow the first constituent. This comes as a sort of a contradiction, considering that adult speakers order old information before new and this has been claimed to be a language universal (Narasimhan & Dimroth, 2008). This preference "is posited to have information processing value for adult speakers since prior mention of a referent facilitates earlier production of the accessible information" (Narasimhan & Dimroth, 2008: 318). Obviously, this tendency becomes adult-like as their language develops and starts resembling that of proper adult speech since the basic word order of English does not allow for such variation.

The studies conducted on Hungarian relied on existing corpora in CHILDES, so it was not possible to control the data. Therefore, the results are generally not statistically significant, with a few exceptions, and can only be viewed as tendencies. However, these tendencies are mostly in line with the hypotheses formulated in all three studies and

they can be taken as informative starting points for further in-depth experiments. Hungarian children use every variable of the default SVO and SOV word orders to differing extent but they use significantly more SVO and SOV orderings, and the more marked word orders have a relatively low frequency. At the two-word stage, children tend to utter approximately more than twice as many SV and VO orders than VS and OV ones. However, this does not mean that they have made a production error but that they have a preference. When they enter the multi-word stage (at around age 2;3) and start producing three-constituent utterances, they prefer the SVO ordering followed by the SOV one, and a significantly smaller number of other orders. Although these rarer word orders (VSO, VOS, OSV, and OVS) occur at a low frequency, they are still present and attest to the flexible nature of Hungarian word order. Their production of non-default orderings increases drastically from age 4. For this reason, it would be especially useful to compile a larger corpus on Hungarian children's language use between ages 4-6 to see if there are any patterns regarding their production of word order (e.g. is there a certain age at which they start using object-initial orders and is it different from the age of subject-initial and verb-initial orders?).

Concerning the ordering of arguments based on their information status in Hungarian, the observed tendencies in Study 3 are in line with the initial hypothesis that children prefer the new-old ordering, similarly as in English (based on Narasimhan and Dimroth, 2008). Due to the flexibility of the language, Hungarian children can vary the word order of their utterances to adhere to their preference for new to old ordering of arguments without producing ungrammatical and pragmatically inappropriate sentences. So, if the object's referent is new in the discourse while the subject's is old, and they prefer to put the new information before the old, then they can employ an object-first word orders (VOS, OVS, or OSV) to express this preference. This is another case in which a larger corpus with older children (ages 4-6) is needed to observe the information status of arguments in three-constituent utterances and make generalizations on the development of this ordering preference. It could be interesting to see how children vary the word order of their utterances to either express this preference

or reject it, and if they do like to order information from new to old (and if this difference is statistically significant) when they switch to the adult-like ordering.

The comparison between these two languages, which are different both typologically and genealogically, is extremely significant for several reasons. If crosslinguistic studies like this have similar findings, it indicates that languages not in close contact and not related have the same or similar properties. This, in turn, might mean that languages in general have core properties that are universal. So, if the acquisition of word order both in English and Hungarian follows the same pattern, despite the languages being completely unrelated, it can be concluded that this process is universal crosslinguistically. The importance of this is immense and should be also tested in other languages that allow flexible word orders (e.g. Turkish, Romanian, Greek, Persian, etc.).

7. Conclusion

The aim of the paper was to investigate the acquisition of word order in a strict word order and a free word order language, the ordering of elements in utterances based on their information status, and draw parallels between the findings. Studies on the English language acquisition process are divided into two types, the ones that rely on the parameter setting hypothesis and the ones relying on the usage-based theory. Both have strong arguments that are essentially opposed to each other, however, their findings are somewhat similar. In the studies reviewed for this paper, the experiments within both frameworks found that children generally tend to adhere to the default SVO order for English from the beginning of the two-word stage, and there might be deviations from it, but those are too slight to be significant in the long run. When it comes to the information status of sentence elements, it has been found in the reviewed studies that young children prefer ordering the elements from discourse-new information to discourse-old information.

The aim of the three studies conducted on Hungarian was to investigate if children acquiring their first language develop their syntactic competence first and use only the default word order of the language, or if their pragmatic awareness develops simultaneously with syntax and they produce all variants of the SVO ordering. The other goal was to see how they order new and old information in three-word utterances. The results indicate that Hungarian children indeed use every type of word order; however they prefer the default word orders of Hungarian (SVO and SOV) with significant differences between these word orders and other possible word orders. They also produce significantly more subject-first sentences than object-first ones, except when the object is in focus position (and the subject is after the verb, OVS). Regarding the information status of the referents, children acquiring Hungarian tend to favour the new to old ordering, i.e. in subject-first utterances the subject's referent is new and the object's is old, while in object-first sentences the object's referent is new in the discourse, however, these are not statistically significant results. Further research is needed to expand the age range to at least 5 or 6 years of age, and investigate the ordering of new information in three-constituent utterances in a larger corpus to get significant results.

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Appendix A: Frequency of use of word orders

N=number of utterances at each age; N_0=number of total utterances and number of utterances for each word order

		Word order																	
Age	**N**	**SV**		**VS**		**VO**		**OV**		**SVO**		**SOV**		**OSV**		**OVS**		**VSO**		**VOS**	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
1;11	**6**	2	33.33	2	33.33	1	16.67	1	16.67	0	-	0	-	0	-	0	-	0	-	0	-
2;3	**16**	11	68.75	1	6.25	4	25	0	-	0	-	0	-	0	-	0	-	0	-	0	-
2;1	**21**	6	28.57	0	-	8	38.09	7	33.33	0	-	0	-	0	-	0	-	0	-	0	-
2;2	**17**	6	35.29	5	29.41	5	29.41	1	5.88	0	-	0	-	0	-	0	-	0	-	0	-
2;3	**90**	22	24.44	15	16.67	28	31.11	14	15.56	6	6.67	3	3.33	1	1.11	0	-	0	-	1	1.11
2;4	**41**	15	36.58	7	17.07	12	29.27	4	9.76	1	2.44	1	2.44	0	-	0	-	1	2.44	0	-
2;6	**36**	13	36.11	9	25	3	8.33	4	11.11	5	13.89	1	2.78	0	-	0	-	1	2.78	0	-
2;7	**30**	10	33.33	4	13.33	5	16.67	9	30	1	3.33	0	-	0	-	0	-	1	3.33	0	-
2;8	**58**	15	25.86	12	20.69	13	22.41	13	22.41	2	3.45	3	5.17	0	-	0	-	0	-	0	-
2;9	**48**	13	27.08	2	4.17	10	20.83	2	4.17	5	10.42	14	29.17	0	-	2	4.17	0	-	0	-
2;10	**36**	23	63.89	1	2.78	9	25	1	2.78	2	5.56	0	-	0	-	0	-	0	-	0	-

2;11	**52**	22	42.31	5	9.61	12	23.08	6	11.54	4	7.69	2	3.85	0	-	1	1.92	0	-	0	-
N_0	**451**	**158**	**35.03**	**63**	**13.97**	**110**	**24.39**	**62**	**13.75**	**26**	**5.76**	**24**	**5.32**	**1**	**0.22**	**3**	**0.67**	**3**	**0.67**	**1**	**0.22**

Appendix B: Ordering of new and old information per word order type

N_0=total number of utterances for each word order; N_3=total number of utterances for each word order at age 3; N_4=total number of utterances for each word order at age 4

		Ordering of information																	
		3-year-olds									**4-year-olds**								
			new-new		**new-old**		**old-new**		**old-old**			**new-new**		**new-old**		**old-new**		**old-old**	
Word order	**N_0**	**N_3**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N_4**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
SVO	106	47	8	17.02	11	23.4	8	17.02	20	42.55	59	15	25.42	9	15.25	14	23.73	21	35.59
SOV	23	13	5	38.46	2	15.38	5	38.46	1	7.69	10	5	50	4	40	1	10	0	-
VSO	26	23	6	26.09	6	26.09	4	17.39	7	30.43	3	0	-	0	-	0	-	3	100
VOS	16	14	5	35.71	3	21.43	1	7.14	5	35.71	2	1	50	1	50	0	-	0	-
OVS	11	6	1	16.67	2	33.33	0	-	3	50	5	1	20	3	60	0	-	1	20
OSV	2	2	0	-	0	-	0	-	2	100	0	0	-	0	-	0	-	0	-
Total	184	105	25	23.81	24	22.86	18	17.14	38	36.19	79	22	27.85	17	21.52	15	18.99	25	31.65

Silvia Martínez-Ferreiro
Department of Nordic Studies and Linguistics, Faculty of Humanities, University of Copenhagen, Denmark
vkw253@hum.ku.dk

Byurakn Ishkanyan
Department of Nordic Studies and Linguistics, Faculty of Humanities, University of Copenhagen, Denmark
fhz406@hum.ku.dk

Vicente Rosell-Clarí
Department of Basic Psychology & Speech Therapy Clinic, University of Valencia, Spain
Vicente.Rosell@uv.es

Kasper Boye
Department of Nordic Studies and Linguistics, Faculty of Humanities, University of Copenhagen, Denmark
boye@hum.ku.dk

UDC 811.134.2'367.625:81'234.2

GRAMMATICAL VERBS IN SPANISH-SPEAKING INDIVIDUALS WITH APHASIA[*]

Abstract: Verbs are among the most intensively studied word classes in aphasia. However, although difficulties with grammatical items are one of the main characteristics of nonfluent aphasias, the relative preservation of grammatical verbs in specific syndromes widely varies across studies. To test whether the lexical-grammatical divide is both theoretically and clinically relevant, we investigated the performance of 9 individuals with mixed and transcortical aphasias of motor predominance (non-fluent) and sensory predominance (fluent), as well as 15 healthy controls. Through the analysis of connected speech, and based theoretically on Franco (2014) and Boye and Harder (2012), we found a reduction in the diversity of grammatical forms in

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nonfluent informants relative to fluent informants. Additionally, non-fluent individuals were found to overproduce repetitions and non-finite forms as compared to NBDs. This is taken as an indicator that the number and diversity of grammatical forms, as well as the number of repetitions and the use of non-finite forms are important variables to consider for the classification of individuals with aphasia, even in the event of mixed deficits of difficult categorization.

Key words: aphasia, verbs, grammatical words, Spanish

1. Introduction

Difficulties with functional/grammatical items, both free standing and bound, are among the generally agreed characteristics of nonfluent aphasias across languages and tasks (production, comprehension and grammaticality judgment) (Parisi & Pizzamiglio, 1970; Goodglass & Kaplan, 1972; Tissot, Mounin & Lhermitte, 1973; Caramazza & Zurif, 1976; Berndt & Caramazza, 1980; Caplan, 1983; Miceli, Silveri, Romani & Caramazza, 1989; Menn & Obler, 1990; Ouhalla, 1993; Hagiwara, 1995; Friedmann & Grodzinsky, 1997, 2000; Avrutin, 2001; Bastiaanse & Thompson, 2003). However, the classification of linguistic items as functional/grammatical (e.g. the pronoun *him* or the past tense marker *-ed*) or content/lexical (words with meaning, e.g. nouns or adjectives) items has largely remained "pretheoretical and intuition-based" (Boye & Harder, 2012: 1). Different parts of speech such as verbs, pronouns and prepositions have been classified as grammatical or lexical *en bloc* based only on the grammatical tradition or on the fact that they constitute closed or open classes – and in absence of any theoretical anchor of such classifications. Whereas words "with little or no meaning" have been traditionally assumed as grammatical, words "with meaning" have been classified as lexical. The lack of a clear theoretical anchor has led to different assumptions across studies and wide variability in experimental results. This pretheoretical understanding of the grammar-lexicon distinction has been challenged in different ways. One challenge is posed by grammaticalization research, which has demonstrated that grammar and lexicon are linked to each other,

forming endpoints of a diachronic continuum (e.g. Hopper & Traugott, 2003). This diachronic continuum has synchronic reflexes, which presents a second challenge: while some items are clearly lexical or clearly grammatical, there is also a grey zone consisting of items that cannot be so easily classified with respect to the distinction (e.g. Corver & van Riemsdijk, 2001). So-called subject-to-subject raising verbs are a case in point. As discussed in Boye (2010), some analyse them as lexical verbs, others analyse them as grammatical verbs, auxiliaries, while still others circumvent the problem and talk about "semi-auxiliaries". In this paper we follow Boye & Harder's (2012) recent functional theory of grammaticalization, which provides a theoretical anchor for the grammar-lexicon distinction (Boye & Harder, 2012), while simultaneously providing a diachronic motivation for continua. According to this theory, the distinction represents a conventionalization (= coding) of information prominence differences: lexical items have the potential to express the main point of a linguistic message, whereas grammatical items are conventionalized as carriers of secondary or background information. This means that lexical items can be identified by their capacity for being focalized. In contrast, grammatical items cannot be focalized independently of their lexical host (outside corrective contexts such as '*No, I said I HAVE run*'). Based on this theory, it has recently been argued that different parts of speech are heterogeneous with respect to the grammar-lexicon distinction, such that the classes of e.g. verbs, pronouns and prepositions comprise both grammatical and lexical members. This theoretical distinction has been demonstrated to correlate with the pattern of performance of people with non-fluent aphasias, who had more problems with elements classified as grammatical by the theory, and people with fluent aphasias, that, conversely, had more problems with lexical elements (Ishkhanyan et al., 2017; Martínez-Ferreiro et al., submitted; Boye & Bastiaanse, submitted). In the case of verbs, this is in line with the view of Franco (2014), according to whom verbs display a graded nature including different forms varying in function and in the amount of lexical content from main fully lexical verbs to mere grammatical functors (inflection holders) (cf. Corver & van Riemsdijk, 2001). In this paper, we have examined grammatical verb

forms in a set of 24 Spanish-speaking individuals, with and without brain damage to show that the lexical-grammatical divide in grammar is both theoretically and clinically relevant. To do so, we have focused on individuals with mixed and transcortical cases of aphasia and on copulas, light verbs and auxiliaries, including modals, aspectuals and temporal forms. These verb forms seem to resist focalization (outside corrective contexts) and thus, in accordance with Boye and Harder (2012), are taken to be grammatical. Building on Franco (2014) and Boye and Harder (2012), we predict that people with non-fluent aphasias should experience more difficulties with semantically light (grammatical/functional) verbs, while individuals with fluent aphasias with anomic predominance should produce an increased rate of complex predicate/light verb constructions. This stands both for the number of grammatical forms and their diversity (Type-Token ratio): Fluent > Non-fluent. Additionally, we expect to find differences in the number of repetitions and the use of non-finite forms between people with non-fluent aphasias and healthy controls: Non-fluent > NBDs.

1.1. Grammatical verbs in Spanish

Spanish includes a complex set of verb forms that are arguably grammatical in the sense defined above, i.e. they are secondary elements carrying background information.

1.1.1. Copulas and light verbs

Copulas are verb forms that have the function of linking a subject to its complement, which may be a determiner, noun, prepositional or adverbial phrase, among other possible configurations (1). As mentioned, these verb forms seem to be grammatical in the sense that they resist focalization. According to Rizzi (1993/4) and Becker (2004), among many others, copulas can be seen as aspectual morphemes that bear inflectional features. In Spanish there are three copular verbs: *ser* 'be' (from the Latin *essere*), which usually refers to characteristics, *estar* 'be' (from the Latin *stare*), which refers to states or situations, and *parecer* 'seem'.

(1) (Él/ella) es/está/parece aburrido.
(s/he) be/seem.present.indicative.3sg bored
‘(S/he) is/seems boring/bored. ’

Copulas may appear as auxiliary verbs expressing passive voice. In Spanish, passives are periphrastic forms built with the copular verb *ser* ‘be’ and the past participle of the main verb with an optional *by* phrase (2).

(2) El apartamento fue vendido por los herederos.
the apartment be.pret.3sg sold.pp by the heirs.
‘The apartment was sold by the heirs.’

Since Jespersen (1965), the term light verb is used to refer to verb forms which, similarly to copulas, are considered to be semantically empty or impoverished. These have been traditionally claimed to be categorically distinct from lexical full verbs, given that their contribution to the meaning of the utterance is minimal. In light verb constructions, it is the complement, in general a deverbal noun, which gives the overall meaning (Alonso Ramos, 2004; Bosque, 2001). They also seem to be grammatical in the sense that they resist focalization (see discussion of Boye & Harder’s (2012) theory above).

(3) Juan le dio una explicación.
Juan. him gave an explanation
‘John gave him an explanation.’

The complex V + N can in many cases be substituted by a full lexical verb (*explain* in (3)). According to Herrero Ingelmo (2002), in Spanish a distinction can be made between verbs of ‘wide spectrum’, generally attested in idiomatic constructions, and verbs of ‘limited use’, which appear in combination with a very limited set of nouns. In this paper, we focus on the set of 6 wide spectrum verbs proposed by Herrero Ingelmo (2002): *dar* ‘give’, *tener* ‘have’, *echar* ‘throw/put’,

hacer 'do', *poner* 'put' and *tomar* 'take' plus the verb *coger* 'catch', when this is used as a synonym of *tomar*.

1.1.2. Temporal, modal and aspectual auxiliaries

In Spanish, both compound tenses and verbal periphrases require the presence of an auxiliary verb. Like the verb forms discussed above, temporal, modal and aspectual auxiliaries are considered to be grammatical (vs. lexical) given that they resist focalization. Accordingly, as in the case of copulas and light verbs, their meaning can be seen as reduced to the point where the verb forms become semantically empty stems to which inflectional affixes attach (aspectual markers) (Guéron & Hoekstra, 1995; Pollock, 1989; Zagona, 2002; Barbiers & Sybesma, 2004). As such, auxiliaries are subject to phonological reduction, and may show a defective inflectional paradigm. Syntactically, these grammatical elements, which allow only one type of complementation and cannot assign theta-roles to arguments, are subject to ordering and co-ocurrence restrictions. Compound perfect tenses, which in contemporary Spanish include 5 indicative tenses (present perfect, past perfect, pluperfect, future perfect, conditional perfect) and 2 subjunctive tenses (present perfect subjunctive, past perfect subjunctive) differ from verbal periphrases in that while the former are considered to be retrospective (4), i.e. used to survey the past, the latter can be seen as prospective (5) (Cartagena, 1999). These clusters include a verb in a non-finite form (the past participle in the case of compound tenses) preceded by an auxiliary (temporal, modal, or aspectual) bearing person/number morphology (Gómez-Torrego, 1999; Cartagena, 1999).

(4) Tú has bailado con María. (Present Perfect)
you have.pres.3sg danced with Mary.
'You have danced with Mary. '

(5) a. *Modal periphrasis*:
Los marineros tenían que salir al mar.
the sailors have.imp.3rd.pl of go-out.inf to-the sea
'The sailors had to go to sea.'

b. *Aspectual periphrasis*:
Las niñas se echaron a llorar.
the girls themselves start.pret.3rd.pl to cry
'The girls started crying. ' (Martínez-Ferreiro, 2010)

There are still other ways to refer to the present, the past or the future, by using periphrastic verbal constructions (6). In (6a), as in the case of passives, a copula may appear as an auxiliary verb expressing progressive aspect:

(6) a. *Present progressive* (*estar* 'to be'+ gerund):
Estoy comiendo.
'(I) am eating. '

b. *Future referring periphrases* (*ir a* 'to go to' + infinitive):
Voy a comer.
'(I) am going to eat. '

Like compound tenses, periphrastic forms, which include modal and aspectual meanings, are composed of an inflected form (modal or aspectual) expressing mood, tense, person and number morphology, and a non-finite verb form (infinitive, gerund or past participle). Modal periphrases (e.g. *deber* 'must' + INF) express obligation, need or desire, i.e. modality, while aspectual periphrases (e.g. *ir a* 'go to' + INF) are related to the action (e.g. terminative periphrases or durative periphrases, among others). There is also a mixed group which includes clusters such as *venir a* 'come to' + INF (Yllera, 1999). The auxiliary verb and non-finite form may be linked directly or by means of a preposition, as in the examples above, or by means of a complementizer (7).

(7) (Yo) tenía que estudiar mucho.
I have.imp.1sg that study.inf a lot
'I had to study a lot.'

Despite constituting a single predicate, some other elements, e.g. adverbs, can be found in between verb forms – see (8).

(8) No podemos en absoluto establecer diferencias.
not be able to.pres.1pl at all establish.inf differences
'We can't detect any differences at all.'

1.2. Previous studies in non-fluent and fluent aphasias

Aphasia is an acquired language disorder resulting from focal damage to the neural tissue supporting the language network. Individuals with aphasia (henceforth IWAs) can be broadly classified into non-fluent and fluent. Non-fluent individuals display problems in production, especially with regard to grammatical elements. Fluent individuals display major problems in comprehension, although anomia is commonly observed in these informants. A large number of studies in typologically different languages have consistently provided evidence that non-fluent individuals experience problems with 'be/have' verbs and auxiliaries, which tend to be omitted or, to a lesser extent, lead to finiteness omissions and tense substitutions (Vermeulen & Bastiaanse, 1984; Nespoulous et al., 1988, 1990; Lapointe, 1985; Saffran et al., 1989; Sasanuma, Kamio & Kubota, 1990; Nadeu & Rothi, 1992; Goodglass et al., 1993; Jonkers, 1993; Friedmann & Grodzinsky, 1997, 2000; Benedet et al., 1998; Garraffa, 2007). Less attention has been given to modals and light verbs (e.g. Barde et al., 2006; Martínez-Ferreiro, 2010). Menn and Obler (1990) examined spontaneous speech data from fourteen languages including, among others, Dutch, Swedish, French, Finnish or Japanese. The results show high omission rates both for copulas and auxiliaries as compared to lexical verbs. Impairment is attested when these forms appear as main verbs and when they are used as auxiliaries (e.g. 'He is a musician' vs. 'He is listening to music'). While copula omissions alone range between 36% and 60% in mandatory contexts, tense substitutions are also widely attested. This pattern of impairment was consistently found across languages. The results of Sasanuma, Kamio & Kubota (1990) in

the analysis of the performance of 2 Japanese speakers with agrammatism showed that the deficit did not expand across all functional forms equally. While omission rates for auxiliaries reached 11.76%, these were as high as 52.94% for copulas. Further evidence from copular and auxiliary verb spontaneous production in English has been reported by Nadeau and Rothi (1992). In this case study, dissociation between 'be/have' verbs and lexical verbs was also observed. While copulas were omitted up to a 36% in mandatory contexts and auxiliary verbs were omitted up to a 22%, lexical verbs were found to be better preserved with omission rates of 7%. Miceli and Mazzucchi (1990) analyzed the production skills of two Italian-speaking individuals with agrammatism. On average, these subjects were found to omit 'be/have' verbs to a 32.5% (vs. 10% of lexical main verbs). In an earlier study including 20 Italian participants with agrammatism, Miceli et al. (1989) provide evidence for the degree of preservation of auxiliary verbs in the production of short narratives. Taken together, and despite considerable cross-subject variation (ranging from 3.1% to 100% omission errors and from 2.3% to 50% substitution errors), the results show a clear tendency towards the omission of auxiliaries (32.66% vs. 10.71%). A third study by Garraffa (2007), observing inflectional morphology in an Italian speaking participant with agrammatism, confirms the low use of grammatical (vs. lexical) verbs in spontaneous speech, consistent with the observations of previous studies. In the 132 narrative sentences included in the analysis, the author reports 100% omission of copulas, 88.4% omission of auxiliaries and 75% omission of lexical have.Nespoulous et al. (1988, 1990) examined the production of 'be/have' verbs and auxiliaries in narrative tasks and vertical reading in two French speaking individuals with agrammatism. The participants in the agrammatic group produced fewer auxiliaries and modals than controls. Participant 1, Mr. Clermont, experienced difficulties both with 'be/have' verbs and auxiliaries, and was found to completely avoid the production of complex verbal clusters, which was attributed to problems in auxiliary production. In the narrative tasks, he omitted 50% of the 'be/have' verbs and 45% of the auxiliaries. The latter were also substituted in 5% of the mandatory contexts. In contrast, he

produced 92% of lexical main verbs correctly. In the same tasks, participant 2 (Mrs. Auvergne) correctly produced 77% of the mandatory auxiliary forms and 96% of the lexical main verbs. The results for vertical reading reflect a task induced facilitatory effect for auxiliaries (90% correct, 10% omitted), while the success ratio remained at the 50% level for 'be/have' verbs (50% correct, 25% omitted, 25% substituted).

Problems with the production of copulas have also been found in structured production tasks, including repetition and oral and written completion tasks. Friedmann and Grodzinsky (2000) report 50% errors in the production of copulas (half of them omissions, half tense substitutions) in a repetition task in Hebrew. The number of errors increases up to 80% in oral completion. The authors account for these findings in structural terms by seeing them as a consequence of the failure to project Tense (*Tree Pruning Hypothesis*, Friedmann & Grodzinsky, 1997, 2000), which causes disruptions in the representation of copulas and auxiliary verbs. Bastiaanse and Thompson (2003) analyzed 8 English speaking individuals with agrammatism for their capacity to produce finite lexical verbs and auxiliaries. The study included a sentence completion task with 3 conditions: "V-in-V", "Aux-in-I" and "Aux-in-C". The results showed that though sentences both with and without the verb in verb position ("V-in-V") turned out to be impaired, percentages of correct answers were higher for those with the verb in that position (37.8% vs. 15.63%). Regarding auxiliaries, the most frequent error was the omission of the auxiliary. In the case of "Aux-in-C", failure to produce the auxiliary in the so called "C position" was as frequent as omitting it (aux. omission: n = 23; wrong position: n = 24). As for "Aux-in-I", omissions coexisted with the production of bare forms (aux. omission: n = 12; stem: n = 7). The results of an additional sentence completion task, run with 9 Dutch and 6 English-speaking participants with agrammatism, confirmed that it is significantly more difficult to produce Dutch finite verbs and English auxiliaries outside verb position than in verb position. Evidence from light verbs is limited. A recent study by Barde et al. (2006) including 23 subjects with fluent and non-fluent aphasias showed that informants with nonfluent aphasia

had greater difficulty producing light verbs compared to verbs that have greater semantic weight (see also Kim & Thompson, 2004). No differences were found for fluent informants (in line with Breedin, Saffran & Schwartz, 1998). Previously existing reports giving particulars of the performance of individuals with non-fluent aphasia in structured tasks in Spanish are scarce. Miera (1996) and Benedet et al. (1998) reported that the verbs 'be' and 'have' are problematic in Spanish. Benedet et al. (1998) found an average of 50% omission errors in a morphosyntax battery. In the lower end, error percentages ranged from 11 to 20% errors for one of the participants and up to 91 to 100% errors for 3 participants. These results are replicated for Spanish and Catalan in Bastiaanse, Rispens, Ruigendijk, Juncos-Rabadán, and Thompson (2002). Rosell (2005) also reported a preference for simple forms in the spontaneous speech of individuals with agrammatism (77.94% simple tenses; 5.69% compound tenses). Martínez-Ferreiro (2010) incorporates evidence from Spanish, as well as Catalan and Galician bilingual speakers. The 16 participants (15 mild Catalan, Galician and Spanish – 5 L1 speakers per language – and 1 moderate L1 Catalan speaker) took part in a task where they had to negate simple declaratives with complex verbal clusters, containing either aspectuals or modals. Out of the 25 tokens, 12 involved verbal periphrases and 13 compound tenses. The Galician test contained verbal periphrases exclusively. In the mild agrammatic sample, the percentage of correct responses for temporal auxiliaries reached 87.69% in Catalan and 73.33% in Spanish, similar to those for tense in lexical main verbs (85% correct). Omissions represented 54.17% of the total number of errors vs. 41.67% of tense substitutions (with the present as the preferred default form) and 4.17% of 'don't know' responses. The results of the Catalan speaking moderate individual (CM) suggest that the deficit in the production of temporal auxiliaries increases with the degree of severity of the agrammatic deficit. CM's 'don't know' responses together with verbless structures represented 69.23% of the total number of elicited responses. Among the items including a verb (n = 4), only two were target responses. Neither the Catalan nor the Spanish control participants made errors. Regarding verbal periphrases, in the mild agrammatic sample, participants

correctly produced complex verbal clusters around half of the time (Catalan: 51.67%, Galician: 56%, Spanish: 63.33%). Wide variability across subjects was attested in the Catalan sample (ranging from 8.33% to 91.67% correct). While 79.24% of the errors consisted of the production of a simple verbal form, 16.04% of the errors entailed the replacement of a modal or an aspectual by a temporal auxiliary. The remaining 4.72% of the errors were tense/agreement substitutions which did not affect the complexity of the verbal cluster. The moderate agrammatic subject CM had problems with the production of all the items. The participants in the control group performed at ceiling across languages (98.78% correct). A further distinction was made between modals, aspectuals, and forms containing characteristics of both groups. The results showed no differences among different types. Mild participants failed to produce modals 45.53% of the time, vs. 43.19% for aspectuals and 30% for unclassified verbal periphrases. Errors in verbal periphrases according to Cinque's (2006) typology are plotted in Table 1 below.

Table 1: Errors in verbal periphrases according to Cinque's (2006) typology (Martínez-Ferreiro, 2010: 140).

Periphrases	***Type***	***Catalan & Spanish*** (errors/total answers)	***Galician***
Aspectuals	Repetitive	0% (0/0)	40% (8/20)
	Terminative	32.5% (13/40)	40% (10/25)
	Durative	70% (14/20)	60% (9/15)
	Inceptive	30% (3/10)	40% (10/25)
Modals	Obligation	40% (12/30)	46.67% (14/30)
	Ability/ Possibility	50% (5/10)	60% (3/5)
Mod./Asp.		40% (4/10)	20% (1/5)

All in all, non-fluent participants display high omission rates for grammatical verbs as compared to lexical verbs. Despite this fact, dissociation between copulas and auxiliaries, with the latter better preserved, have been found in several languages. Tense and temporal auxiliaries were found to be damaged to the same extent, and better preserved than modals and aspectuals. As for the contrast between modals and aspectuals, the scarcity of data does not allow generalizations with respect to their degree of preservation. Regarding the nature of errors, omissions are prominently attested crosslinguistically. To a lesser extent, tense substitutions are also documented. In these cases, the present seems to be the default form for substitution, although finiteness omissions have also been reported. The results for fluent deficits are more contradictory. Individuals with anomia have been reported to overproduce auxiliaries in comparison to NBDs in some studies (e.g. Vermeulen & Bastiaanse, 1984). However, no asymmetries were detected in others (e.g. Jonkers, 1993). More consistently, asymmetries were found between fluent and non-fluent individuals as for the qualitative error patterns, with fluent IWAs showing a tendency to substitute auxiliaries (generally omitted in agrammatic speech) (Goodglass et al., 1993).

As stated above, in this paper we aim at investigating the use of grammatical/functional verbs (including copulas, light verbs, modals, aspectuals, and temporal auxiliaries) in the speech output of individuals with mixed and transcortical aphasias. Based on previous findings and on the theoretical framework granted by Boye and Harder (2012) and Franco (2014), we predict that non-fluent deficits will be manifested as a reduction of semantically light (grammatical/functional) verbs affecting both the number of (finite) verb forms and their diversity (increased number of repetitions, lower type-token ratio), while fluent aphasias will result into an increased rate of complex predicate/light verb constructions. However, in mixed cases of unclear (not very marked) predominance, the duality of the clinical profile is seen as susceptible of cancelling out the effect, thus accounting for part of the variability observed across studies and informants.

2. Methods

2.1. Participants

Semi-spontaneous (elicited) speech samples of 24 Spanish-speaking participants, comprising adult individuals with fluent and non-fluent chronic aphasias (n = 9) and adult individuals without brain damage (n = 15), were analyzed. A summary of the profile of the participants is included in Table 2. Information per participant is included in Appendix A.

Table 2: Summary of participants

Group	***Age***	***Gender***	***Aphasia type***	***Severity***
Non-fluent (n = 6)	65.6 (40-82)	3 males	2 Transcortical motor 2 Mixed predominantly motor 2 Mixed predominantly motor with signs of transcorticality	3 mild 3 moderate
Fluent (n = 3)	64 (53-71)	3 males	3 Mixed aphasia predominantly anomic	2 mild 1 moderate
NBDs (n = 15)	58 (47-68)	9 males		

The participants with aphasia were taken from the Rosell corpus (2005). The sample includes 6 non-fluent and 3 fluent individuals (6 male; 5 mild and 4 moderate) with an age range of 40-82 years (mean age 64.8) and varying educational and professional backgrounds. Most participants were bilingual (Spanish-Valencian). Valencian is a variety of Catalan spoken in the Valencian Community (Spain) typologically similar to Spanish. However, all participants declared Spanish as their first language. All 9 participants suffered aphasia, confirmed by the results of the BDAE (Goodglass & Kaplan, 1972, 1983; Spanish version: García-Albea, Sánchez Bernardos & del Viso Pabón, 1986), as

a consequence of a cerebrovascular accident (CVA) in the left hemisphere, but presented normal or corrected to normal vision and hearing at the time of testing (time post-onset > 1 year). For further details about the specifics of the lesions and the psycholinguistic profile in the aphasia group, the reader is referred to Rosell (2005). A sample of 15 matched adults without brain damage (9 male), ranging from 47 to 68 years of age (mean age: 58), were also tested for comparison.

2.2. Procedure & analysis

We analyzed the written transcripts of semistandardized interviews conducted in Spanish evoking past, present, and future events. (Rosell, 2005). Questions included reference to the last job carried out by the informants, the last holidays they enjoyed and the hobbies and activities they currently do or want to do in the close future. Connected speech was chosen due to its ecological value, given that it provides insights into the communicative abilities of the informants in their daily life.

Following criteria from Vermeulen et al. (1989) and Nicholas & Brookshire (1993), the quantitative and the qualitative analyses were conducted over a subset of 300 words per participant. Functional verbs were extracted and classified into different categories: copulas, light verbs, and auxiliaries, including modals and aspectuals. For the inclusion of verb forms, at least 60% of a word had to be produced in a recognizable fashion. Total number of occurrences (finite and non-finite), repetitions and type/token ratios were included in the analysis to examine both frequency of use and diversity.

To verify the reliability of the method of analysis, the samples were examined by two independent, experienced raters. Conflictive cases were noted, and final decisions were made by consensus. All grammatical verbs, finite and non-finite (including repetitions), were considered in the general analysis with the exception of verbs embedded in frozen constructions. These included copulas used as part of the explicative conjunction *es decir* ‘that is’ (n = 14). Only one participant in the non-fluent group (JRA) produced examples of code-

switching and code-mixing in his speech output. The four grammatical verbs produced in Valencian, one modal verb, one light verb, one temporal auxiliary and one copula, were included in the general word count.

Aphasia group (fluent, non-fluent) was taken as the grouping variable. Effects due to repetitions and finiteness were reported when relevant. Since the group scores were not normally distributed, Kruskal–Wallis and (post-hoc) Mann-Whitney-U tests were used for statistical comparisons across groups (e.g. aphasia vs. NBDs). Friedman tests and (post-hoc) Wilcoxon signed-rank tests were run for comparisons across dependent variables (e.g. modals vs. aspectuals). These tests were administered using SPSS 24.0. In addition to group measurements, the significance of the individual performance of participants with aphasia was also calculated, based on Crawford & Howell (1998) and Crawford & Garthwaite (2002). For the sake of clarity, only significant differences are reported, except for the general results. This holds both at the group and at the individual level.

3. Results

The general results are summarized in Table 3:

Table 3: Results of the analysis of functional verbs (TTR = type/token ratio, NBD = non-brain-damaged speakers).

Group means	***NBDs (n = 15)***	***Fluent (n = 3)***	***Non-Fluent (n =6)***
Total grammatical verbs	18.5	25.33	22
TTR (grammatical verbs)	0.36	0.28	0.27
Copulas	11.27	12.33	11.5
TTR (copulas)	0.22	0.21	0.18
Mean Light Verbs	1.73	1.33	1
TTR (light verbs)	0.61	1	0.3
Modals	3.07	1.33	3
TTR (modal verbs)	0.57	1	0.39
Aspectuals	2.07	2.67	1.5
TTR (aspectuals)	0.77	0.78	0.38
Temporal Auxiliaries	0.4	7.67	5

The overall results indicate that subjects in the NBD group produce fewer functional/grammatical verbs than participants in the aphasia group. However, no significant differences were found in the statistical tests when all verbs were analyzed together (Kruskal Wallis: $\chi 2$ (2, N = 24) = 1.288, p = .525). The individual analysis revealed that only 3 participants scored higher than the NBDs (S01: t = 1.902, p = .039, S02: t = 4.082, p = .001; S06: t = 2.810, p = .007).

Differences were found for the number of repetitions (Kruskal Wallis: $\chi 2$ (2, N = 24) = 8.842, p = .011). Non-fluent participants produced significantly more repetitions of functional/grammatical

verbs than NBDs (Mann Whitney: U = 12; Z = -2.858, p = .004). However, the general results did not change when repetitions were left out of the analysis.

Contrary to the total number of occurrences, the analysis of the general type/token ratio showed that NBD informants used a wider array of grammatical verbs than participants with aphasia (Mann Whitney: U = 33; Z = -2.059, p = .039), but group differences did not reach significance in the statistical analysis (Kruskal Wallis: $\chi 2$ (2, N = 24) = 4.663, p = .097). Although only two participants with aphasia were found to differ from controls (S02: t = -2.259, p = -020; S10: t = -2.044, p = .030), the type/token ratio of non-fluent individuals was found to be significantly lower than in the NBD group (Mann Whitney: U = 16.5; Z = -2.221, p = .026).

In order to investigate if the performance was stable across grammatical verbs, we classified these forms into different categories: copulas, light verbs and auxiliaries (including modals, aspectuals and temporal auxiliaries). All three groups of participants produced a higher percentage of copulas followed by auxiliaries and finally light verbs. A Friedman test confirmed that differences were significant for non-fluent and control individuals ($\chi 2(2) = 10.333$, p = .006 and $\chi 2(2) = 24.667$, p = .000, respectively), but not in the fluent group ($\chi 2(2) = 4.667$, p = .097). We attribute the lack of differences to the reduced number of participants in this group.

Across groups, differences in the total number of occurrences reached significance only for the group of auxiliaries (Kruskal Wallis: $\chi 2$ (2, N = 24) = 6.944, p = .031). A summary of differences in the distribution of verb forms across types are illustrated in Figure 1.

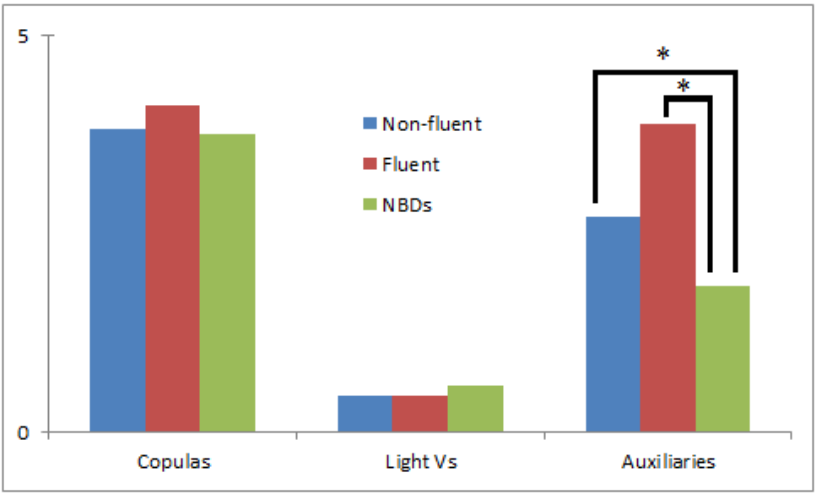

Figure 1: Percentage of grammatical verbs across groups.

In what follows we provide a detailed analysis of the different grammatical verbs included in the analysis.

3.1. Copulas

A total of 275 copular verbs were analyzed. As expected, the highest mean of copular verb production is that of the 3 participants in the fluent group (mean: 12.33, total = 27), followed by the 6 non-fluent participants and the 15 participants in the NBD group, who had similar scores (Non-fluent mean: 11.5, total = 69; NBD mean: 11.27, total = 169). However, the fluent group is also the group with the highest standard deviation (SD fluent: 8.39; SD non-fluent: 5.58; SD NBDs: 3.22). Group results showed no differences between participants with aphasia and NBDs (Kruskal Wallis: $\chi 2$ (2, N = 24) = .332, p = .847). Two participants produced more copulas than their NBD counterparts (S01: t = 2.625, p = .010; S02: t = 3.226, p = .003).

Differences were found when repetitions and finiteness were taken into account. As for the number of repetitions (Kruskal Wallis: $\chi 2$ (2, N = 24) = 6.240, p = .044), non-fluent individuals produced a higher number of repetitions of copular verbs than their NBD counterparts (Mann Whitney: U = 16.5; Z = -2.483, p = .013). For non-

finite forms, we found marginally significant differences (Kruskal Wallis: $\chi 2$ (2, N = 24) = 5.379, p = .068). Further post hoc testing confirmed that individuals in the non-fluent group produced a higher number of non-finite copulas than control individuals (Mann Whitney: U = 18; Z = -2.220, p = .026).

Across forms, *ser* 'be' was the most productive copula (n = 174), followed by *estar* 'be' (n = 95) and *parecer* 'seem' (n = 6). For the distribution of responses across forms, see Appendix B. Differences between participants with aphasia and NBDs were marginally significant in the case of *parecer* 'seem', which was only produced in its finite form by NBDs (Mann Whitney U test: U = 45; Z = -1.897, p = .058).

Given that the inventory of copulas is very limited, no differences were found in the type/token ratio (Kruskal Wallis test: $\chi 2$ (2, N = 24) = .058, p = .972). At the individual level, 2 fluent and 2 non-fluent informants were found to differ from the NBD group in the production of the verb *ser* (S01: t = 5.647, p = .000; S02: t = 5.140, p = .000; S03: t = -2.464, p = .014; S07: t = -3.478, p = .002). No differences were observed for *estar*.

3.2. Light verbs

A total of 36 'wide spectrum' light verbs were produced by our 24 informants. For the distribution of responses across verbal forms, see Appendix C. No repetitions were attested. NBD individuals produced 26 instances of light verbs (Mean = 1.73, SD = 1.75), followed by fluent (N = 4, Mean = 1.33, SD = 0.58) and non-fluent individuals (N = 6, Mean = 1, SD = 1.26). As in the case of copulas, these differences did not reach significance in the statistical tests, neither at the group level (Kruskal Wallis: $\chi 2$ (2, N = 24) = .999, p = .207), nor at the individual level. Finiteness was not found to have an effect.

The tendency of the type/token ratio follows our predictions: fluent participants have the highest mean (Mean: 1; SD: 0), followed by NBDs (Mean: 0.61; SD: 0.41) and non-fluent participants (Mean: 0.3, SD: 0.4). Despite the inclusion of a limited subset of light verbs in

our analysis, significant differences were found across groups (Kruskal Wallis: $\chi 2$ (2, N = 24) = 6.029, p = .049). Further post hoc testing confirmed that fluent participants had a higher type/token ratio than non-fluent participants (Mann Whitney: U = 1.5; Z = -2.060, p = .039).

3.3. Modals, aspectuals and temporal auxiliaries

A total of 175 forms were identified in the speech output of our 24 participants: 68 modal verbs, 48 aspectual verbs, and 59 temporal auxiliaries. Contrary to what we expected, participants with aphasia produced more auxiliary verbs than NBDs, with fluent participants producing the highest number of forms. Post hoc tests revealed that there were differences between fluent and non-fluent participants and NBDs (Mann Whitney - Fluent: U = 6; Z = -1.978, p = .048; Non-fluent: U = 18.5; Z = -2.084, p = .037).

Differences were also found for the number of repetitions produced across groups (Kruskal Wallis: $\chi 2$ (2, N = 24) = 11.723, p = .003). These differences hold for fluent and non-fluent participants vs. NBDs (Mann Whitney - Fluent: U = 15; Z = -2.236, p = .025; Non-fluent: U = 15; Z = -3.409, p = .001), but not across aphasia groups. When repetitions of auxiliary verb forms are subtracted from the total number of auxiliaries, differences only hold for fluent vs. NBD informants (Mann Whitney: U = 5; Z = -2.098, p = .036).

The analysis of finite forms alone rendered similar results to those for all verbs together, with NBDs producing fewer auxiliary verbs than individuals with aphasia (Kruskal Wallis: $\chi 2$ (2, N = 24) = 8.137, p = .017). Post hoc testing showed that, again, differences were restricted to fluent and non-fluent participants vs. NBDs (Mann Whitney - Fluent: U = 4.5; Z = -2.176, p = .030; Non-fluent: U = 17.5; Z = -2.173, p = .030).

The type/token ratio was also different across groups (Kruskal Wallis: $\chi 2$ (2, N = 24) = 11.998, p = .002). Contrary to the number of occurrences, which was lower for NBDs than for informants with aphasia, diversity indices auxiliary verbs were higher for healthy controls than for any of the participants in the aphasia groups: Mann

Whitney - Fluent: U = 2.5; Z = -2.444, p = .015; Non-fluent: U = 8; Z = -2.937, p = .003.

A Friedman test confirmed differences across auxiliaries for non-fluent and control individuals ($\chi2(2) = 6.348$, p = .042 and $\chi2(2) = 11.640$, p = .003, respectively), but not for the fluent group ($\chi2(2) = 2.364$, p = .307). We attribute the lack of differences to the reduced number of participants in this group. Subsequent post hoc analysis showed that non-fluent individuals produced more temporal auxiliaries than aspectuals (Wilcoxon: Z = -2.214, p = .027). The opposite pattern was found for NBDs, who produced more modals (Wilcoxon: Z = -2.885, p = .004) and aspectuals (Wilcoxon: Z = -2.694, p = .007) than temporal auxiliaries. The distribution of forms across groups is summarized in Table 4:

Table 4: Modals, aspectuals and temporal auxiliaries across groups.

Verbs	***NBDs***	***Fluent***	***Non-fluent***
Modals	N = 46 Mean: 3.07 SD: 2.74	N = 4 Mean: 1.33 SD: 0.58	N = 18 Mean: 3 SD: 1.90
Aspectuals	N = 31 Mean: 2.07 SD: 1.94	N = 8 Mean: 2.67 SD: 2.89	N = 9 Mean: 1.5 SD: 2.07
Temporal Auxiliaries	N = 6 Mean: 0.4 SD: 0.51	N = 23 Mean: 7.67 SD: 5.69	N = 30 Mean: 5 SD: 4

A total of 68 modal verbs were found in our corpus, 66 finite and 2 non-finite forms. For the distribution of responses across categories, see Appendix D. Although the mean production of modals is higher in the NBD group than in the non-fluent and the fluent groups, respectively, the comparison did not reach significance in the statistical analysis (Kruskal Wallis: $\chi2$ (2, N = 24) = 1.929, p = .381). Differences according to fluency were restricted to modals denoting obligation (Kruskal Wallis: $\chi2$ (2, N = 24) = 7.074, p = .029), and, more specifically, to the contrast between fluent and non-fluent individuals (Mann Whitney: U = .000; Z = -2.828, p = .005).

Differences across groups arise for the number of repetitions (Kruskal Wallis: $\chi 2$ (2, N = 24) = 6.273, p = .043). Non-fluent individuals produced significantly more repetitions of modal verbs than the informants in the NBD group (Mann Whitney: U = 30; Z = -2.294, p = .022). However, there were no differences in the general results when repetitions were left out of the analyses. This is also the case for finiteness, given than only 2 out of the 68 modals were non-finite. None of the 9 participants with aphasia differed significantly from the NBDs in the individual analysis.

As for the diversity of forms, as we expected, the calculation of the type/token ratio revealed the following pattern: Fluent > NBDs > Non-fluent. Differences were found to be significant (Kruskal Wallis: $\chi 2$ (2, N = 24) = 6.029, p = .049), mainly due to differences between fluent and non-fluent individuals (Mann Whitney: U = 1.5; Z = -2.060, p = .039).

In addition to modal verbs, our sample included 48 instances of aspectual verbs, 41 finite and 7 non-finite forms. For the distribution of responses across categories, see Appendix E. On average, aspectual verbs appear more frequently in the speech output of fluent participants than in NBDs and non-fluent participants (Mean Fluent: 2.67, NBDs: 2.07, Non-fluent: 1.5). No repetitions were found. As in the case of modals, no significant differences were found across groups (Kruskal Wallis test: $\chi 2$ (2, N = 24) = 1.368, p = .505). This was also the case when finite and non-finite forms were analyzed separately. Individual tests confirmed that none of the informants differed with respect to the NBD group.

Contrary to modals, no overall differences were found in the type/token ratio of aspectual verbs across groups (Kruskal Wallis: $\chi 2$ (2, N = 24) = 4.637, p = .098). However, non-fluent individuals had significantly lower scores than NBDs (Mann Whitney: U = 20; Z = -2.076, p = .038). In the individual analyses, 3 out of the 6 informants in the non-fluent group adhered to this pattern (S07, S08, S09: t = -1.989, p = -033).

Finally, an additional set of 59 temporal auxiliaries (56 finite) was analyzed. Fluent participants produced the highest number of forms, followed by non-fluent participants (Fluent – Mean: 6.67, SD:

4.04; Non-fluent – Mean: 5, SD: 4; NBDs – Mean: 0.33, SD: 0.49). For the distribution of responses across forms, see Appendix F. Differences in the production of the auxiliary verb 'have' were found to be significant (Kruskal Wallis: $\chi 2$ (2, N = 24) = 17.727, p = .000). Post hoc tests revealed differences between NBDs and both aphasia groups in Mann-Whitney U Tests (Fluent: U = .000; Z = -2.963, p = .003; Non-fluent: U = .000; Z = -3.740, p = .000), but not across aphasia groups.

This was also the case when repetitions were left out of the analysis (Kruskal Wallis: $\chi 2$ (2, N = 24) = 16.850, p = .000), despite a significantly higher number of repetitions in participants with aphasia (Mann Whitney: U = 30; Z = -3.155, p = .002), or when finite forms were analyzed alone (Kruskal Wallis: $\chi 2$ (2, N = 24) = 17.727, p = .000). We attribute this effect to an artefact of data collection. As mentioned, one of the semistandardized interviews used to elicit data was centered on the topic 'last holidays'. This interview was recorded immediately after the summer break in the case of participants with aphasia, favouring the use of the present perfect, built with the auxiliary 'have' – but months afterwards in the case of controls, requiring the use of the simple past.

The use of the verb 'be' as a passive auxiliary was restricted to fluent individuals (3 out of the 4 forms attested). However, the low number of instances prevented us from finding significant differences (Kruskal Wallis: $\chi 2$ (2, N = 24) = 3.209, p = .201). Interestingly, none of the participants in the non-fluent group produced passive constructions. An effect of fluency was found in the analysis of non-finite temporal auxiliaries (Kruskal Wallis: $\chi 2$ (2, N = 24) = 7, p = .030). Fluent participants were found to produce a significantly higher number of non-finite forms than NBDs (Mann Whitney: U = 15; Z = -2.236, p = .025). However, this did not alter the general results.

Overall, no significant differences were found as for the total number of functional/grammatical verb forms produced in the NBD and the aphasia groups when all verbs were analyzed together. Differences were restricted to the group of auxiliary verbs. However, we found that non-fluent participants produced significantly more

repetitions and their type/token ratio was lower than in NBD informants.

4. Discussion

High omission rates for grammatical verbs as compared to lexical verbs in non-fluent individuals have widely been attested in the literature. Additionally, dissociation between different grammatical verbs has also been reported. For instance, auxiliaries have been found to be better preserved than copulas, modals, and aspectuals and to the same extent as tense in several languages (Vermeulen & Bastiaanse, 1984; Nespoulous et al., 1988, 1990; Lapointe, 1985; Saffran et al., 1989; Sasanuma, Kamio & Kubota, 1990; Nadeu & Rothi, 1992; Goodglass et al., 1993; Jonkers, 1993; Friedmann & Grodzinsky, 1997, 2000; Benedet et al., 1998; Garraffa, 2007). However, most of these studies focus on individuals with Broca's aphasia and agrammatism and very few cases of fluent aphasias are documented. Moreover, copulas and temporal auxiliaries are the main focus of attention and data from modals, aspectuals and light verbs are still scarce (Barde et al., 2006; Martínez-Ferreiro, 2010). Our results highlight the relevance of characterizing cases of mixed and transcortical aphasias through exhaustive analyses of spontaneous speech for the proper characterization of aphasia related symptoms.

In this paper, we investigated the use of copulas, light verbs, modals, aspectuals and temporal auxiliaries in the speech output of individuals with mixed and transcortical aphasias focusing on the number of occurrences (finite and non-finite) and diversity (repetitions and type/token ratio). Based on previous findings and on the theoretical accounts by Boye and Harder (2012) and Franco (2014), we predicted a reduction of semantically light (grammatical/functional) verbs affecting both the number of (finite) verb forms and their diversity in non-fluent individuals, including more repetitions and a lower type-token ratio, while fluent aphasias were expected to result in an increased rate of complex predicate/light verb constructions. Mixed cases of unclear (not very marked) predominance were considered of

special interest due to the duality of the clinical profile including motor and sensory symptoms, which was expected to affect the significance of the results.

Based on the existing literature and according to the predictions born out from Boye and Harder (2012), we expected the following outcomes:

(9) a. *Number and diversity of grammatical forms*:
Fluent > Non-fluent
b. *Repetitions and non-finite forms*:
Non-fluent > NBDs

Taken together and contrary to what would be expected based on previous results from individuals with Broca's aphasia and/or agrammatism, we found no general differences for the number of occurrences of functional/grammatical verbs in people with aphasia. This is the case for both predominantly fluent and non-fluent mild and moderate participants. However, a more exhaustive analysis revealed that despite the complexity of the characterization of these aphasia cases, many prototypical markers can still be identified. As expected, significant differences were found in the number of repetitions: non-fluent participants produced more repetitions than their NBD counterparts.

Then, we analyzed the outcomes for specific types of grammatical verbs. A summary of results according to the predictions in (9) has been added in Table 5, which includes significant differences in the number of verbs (including non-finite forms), type/token ratios, and repetitions (✓).

Table 5: Summary of statistically significant results (TTR = type/token ratio, NBD = non-brain-damaged speakers, NF = non-fluent speakers, F = fluent speakers).

	Fluency	***Cop.***	***LVs***	***Mod.***	***Asp.***	***Have***	***Be***
Total	F > NF	X	X	X (✓ oblig)	X	X	X
TTR	F > NF	X	✓	✓	X[1]	---	---
Reps	NF > NBD	✓	---	✓	---	✓	---
Non-fin	NF > NBD	✓	X	X	X	---	X[2]

✓ = prediction confirmed; X = prediction not confirmed; 1. NF < NBD; 2. F > NBD

As illustrated in Table 5, and according to our predictions, fluent participants produced more copulas than NBDs and non-fluent individuals on average. However, the low number of informants in this group and a high standard deviation prevented us from finding significant differences. Additionally, non-fluent individuals produced a higher number of repetitions and non-finite forms than NBDs. Differences also emerged for the inventory of copulas produced by the informants. The performance of individuals with aphasia differed significantly from the performance of the NBD group. While NBD participants produced instances of all three copular verbs (*ser*, *estar* and *parecer*), participants with aphasia restricted themselves to the use of the verb 'be' (*ser* and *estar*). Non-fluent participants had a lower type/token ratio than NBDs. At the individual level, none of the participants with aphasia differed from NBDs in the use of *estar*. Individual deviant patterns were found in the production of *ser*. Wide spectrum light verbs were scarce in our sample. NBDs produced more tokens than individuals in the aphasia group. Again, the mean was higher in the case of fluent participants than in the non-fluent group, although differences did not reach significance. Differences emerge if

diversity (TTR) is considered (fluent participants > NBDs > non-fluent participants). The contrast between aphasia groups (fluent vs. non-fluent) was found to be significant. Regarding the production of auxiliaries, contrary to what we expected, participants with aphasia produced more auxiliary verbs than NBDs, with fluent and mild participants producing the highest number of forms. Differences were also found in the number of repetitions. All individuals with aphasia produced significantly more repetitions than the informants in the control group. When repetitions were subtracted from the total number of auxiliaries, differences only held for fluent vs. NBD informants. An effect of finiteness was also found. Contrary to what we expected, all individuals with aphasia were found to produce a significantly higher number of finite forms than NBDs. However, the analysis of the type/token ratio confirmed that diversity is higher for NBDs than for informants with aphasia. Across forms, as in Martínez-Ferreiro (2010), non-fluent individuals produced a higher number of temporal auxiliaries than modals or aspectuals. As for the latter, we again expected fluent participants to overproduce these forms, as opposed to non-fluent participants: fluent > NBDs > non-fluent. This was found to be the tendency for aspectuals (average of use and diversity). Although group analyses did not reach significance in the statistical tests, non-fluent informants were found to have a significantly lower type/token ratio than their NBD counterparts. For modal verbs, overall differences were only found for diversity, significantly higher in the fluent group than in participants with non-fluent deficits. Differences in the number of forms only reached significance for modals expressing obligation (fluent > non-fluent). Non-fluent participants were found to produce a significantly higher number of repetitions than NBDs. Significant differences were also found in the analysis of temporal auxiliary verbs when these were analyzed together. Finiteness was also found to have an effect on 'have' and 'be' auxiliaries. Due to an artefact in data collection, participants with aphasia were found to produce a higher number of finite 'have' auxiliaries than NBDs. However, with the verb 'be', fluent participants produced more non-finite passive auxiliaries than NBDs, indicating difficulties in the production of passive forms.

Interestingly, none of the non-fluent participants produced passive auxiliaries.

In this article, we have focused on grammatical verbs in a limited number of informants. We attributed the lack of statistical differences between the aphasia groups (fluent-non-fluent, mild-moderate) to the size of the sample but also to the dual nature of the symptoms of participants with mixed aphasia. Still, in these cases, diversity measurements (number of repetitions and type/token ratios) were found to capture the fluent-non-fluent distinction more accurately than those focusing on number of occurrences (presence of finite and non-finite forms).

5. Conclusion

In sum, in line with previous findings, the number and diversity of grammatical forms, together with the number of repetitions and the use of non-finite forms, are still important variables to consider for the classification of individuals with mixed aphasias. Although the general observations for prototypically non-fluent (e.g. agrammatism) and fluent aphasias (e.g. anomia) still apply, the mixed nature of the deficits described here makes the results of the comparisons less clear-cut. These results capitalize on the importance of the analysis of spontaneous speech data to perfom in-depth explorations of individual cases and account for variation.

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Appendix A: Background information of participants

Aphasia						
Participant	***Age***	***Gender***	***Etiology***	***Type of aphasia***	***Severity***	***BDAE Auditory Comp.***
JHG	40	M	CVA	Transcortical motor	Mild	92.01
JHC	71	M	CVA	Mixed predominantly anomic	Mild	87.5
VMH	53	M	CVA	Mixed predominantly anomic	Moderate	65
JPC	65	M	CVA	Mixed predominantly motor	Moderate	61.18
BPL	68	M	CVA	Mixed predominantly anomic	Mild	71.18
CAR	82	F	CVA	Mixed predominantly motor	Moderate	61.87
CMG	72	F	CVA	Mixed predominantly motor with signs of transcorticality	Mild	72.71
JRA	75	M	CVA	Mixed predominantly motor with signs of transcorticality	Moderate	77.15
TCP	60	F	CVA	Trasncortical motor	Mild	86.73

NBD					
Participant	***Age***	***Gender***	***Participant***	***Age***	***Gender***
1	64	M	**9**	64	F
2	63	F	**10**	52	M
3	54	M	**11**	55	F
4	55	M	**12**	60	M
5	54	F	**13**	47	M
6	68	M	**14**	60	F
7	57	M	**15**	58	M
8	57	F			

Appendix B: Copular verbs according to fluency and severity

	Ser	***Estar***	***Parecer***
Non-fluent	50	19	0
Fluent	23	14	0
NBDs	101	62	6
Mild	49	23	0
Moderate	24	10	0
Total:	**174**	**95**	**6**

Differences in the distribution of *ser* ‘to be’, *estar* ‘to be’, and *parecer* ‘to seem’ were significant in the speech output of NBDs and non-fluent informants (Friedman – NBDs: $\chi2(2) = 22.407$, $p = .000$; Non-fluent: $\chi2(2) = 8.273$, $p = .016$).

Appendix C: Light verbs according to fluency and severity

	Coger/Tomar	***Dar***	***Echar***	***Hacer***	***Poner***	***Tener***
Non-fluent	0	1	0	4	1	0
Fluent	0	1	0	2	0	1
NBDs	5	7	1	8	0	5
Mild	0	2	0	2	0	0
Moderate	0	0	0	4	1	1
Total:	**5**	**9**	**1**	**14**	**1**	**6**

Differences in the distribution of forms were only significant in the speech output of NBDs (Friedman – NBDs: $\chi 2(2) = 13.349$, $p = .020$).

Appendix D: Modal verbs according to fluency and severity

	Capacity	***Obligation***	***Possibility/ Probability***
Non-fluent	8	0	3
Fluent	0	3	1
NBDs	11	13	11
Mild	4	2	2
Moderate	4	1	2
Total:	**19**	**16**	**15**
	Skill	***Wish/ Desire***	
Non-fluent	2	5	
Fluent	0	0	
NBDs	0	11	
Mild	2	4	
Moderate	0	1	
Total:	**2**	**16**	

Significant differences across types of modals were found in the performance of NBDs and fluent participants (Friedman – NBDs: $\chi 2(4) = 11.977$, $p = .018$; Fluent: $\chi 2(4) = 9.714$, $p = .046$).

Appendix E: Aspectual verbs according to fuency and severity

	Durative	***Habitual***	***Ichoative***
Non-fluent	3	1	0
Fluent	3	0	0
NBDs	12	2	1
Mild	3	0	0
Moderate	3	1	0
Total:	**18**	**3**	**1**
	Ingressive	***Reiterative***	***Resultative***
Non-fluent	3	0	2
Fluent	4	0	1
NBDs	9	2	5
Mild	3	0	2
Moderate	4	0	1
Total:	**16**	**2**	**8**

Significant differences across types of aspectuals were only found in the performance of NBDs (Friedman: $\chi 2(5) = 13.621$, $p = .018$).

Appendix F: Temporal auxiliaries according to fluency and severity

	To have	***To be (passive)***
Non-fluent	30	0
Fluent	20	3
NBDs	5	1
Mild	23	3
Moderate	27	0
Total:	**55**	**4**

Differences between auxiliaries were significant only in the case of non-fluent individuals (Wilcoxon: $Z = -2.226$, $p = .026$).

Johanne Kron Nedergaard
Department of Experimental Psychology, University of Oxford, United Kingdom
johanne.nedergaard@bnc.ox.ac.uk

UDC 159.953.4:81'37
81'234

SEMANTIC KNOWLEDGE IN THE BRAIN: ACCESS, INTEGRATION, AND STORAGE

Abstract: Semantic knowledge is the aspect of human memory that holds general information about word meanings, facts, objects, and people without connection to a particular point in time or space. It is a relevant area of cognition to study because it provides us with an interface between perception and action, as well as a basis for abstract, offline cognitive processes. The precise nature of this conceptual knowledge store is a contested matter. Primarily, there is disagreement on two fronts; first, whether semantic knowledge is stored in a modality-specific way (visual, auditory, verbal, etc.) or whether there is an amodal store, and second, where this central store is located if it exists. This paper aims to provide an investigation into the question of how semantic knowledge is accessed and represented in the brain with particular focus on verbal/lexical access. I will present arguments in favour of the view that semantic knowledge is widely distributed with a hub located in the anterior temporal lobe (ATL), as well as examine evidence from lesion studies, neuroimaging studies, word elicitation studies, and interference studies with healthy participants. I will assess the theoretical importance of lexical access effects (primarily frequency, age-of-acquisition, and semantic priming), semantic dementia, and category-specific semantic deficits such as the dissociation between semantic knowledge about living and non-living entities. In the end, I will conclude that there is support for the idea that semantic knowledge is represented according to associative networks crucially related to sensory modality, but that this distributed network is connected to a hub located in the anterior temporal lobe where information is integrated and where we form coherent concepts and compare similarities.

Keywords: Semantic knowledge, mental lexicon, semantic dementia, category-specific semantic deficits, anterior temporal lobe, lexical access

1. Introduction

Before one attempts to study how semantic knowledge is represented in the brain, it is necessary to clarify what one means by this abstract notion. In this paper, semantic knowledge will be defined as the component of memory that represents general knowledge of entities such as objects, people, word meanings and facts, without relation to any specific context. The notion of semantic knowledge as an interactive conceptual network of associations gives rise to some interesting questions, some of which have received more attention in the literature than others. How does sound become meaning, and how does meaning become sound? How do we integrate properties and arrive at a categorical concept? What happens when the semantic system breaks down, and how can this help us understand how it is organised? As with many of the more complex cognitive functions, semantics is difficult to elucidate because we have to study it indirectly through access tasks and lesion studies. One of the most influential current models of speech processing by Hickok and Poeppel (2007) states that the so-called conceptual network is widely distributed, and this is indeed the approach taken by many psychologists and neuroscientists studying language and meaning in the brain. In this paper, I will first discuss the methods used to access semantic knowledge and then proceed to describe the evidence for a distributed conceptual network, which includes observations of patients with selective semantic impairments. In this context, I will also discuss the possibility of a central 'hub' where semantic properties are integrated to form coherent concepts (suggested by Patterson, Nestor, and Rogers, 2007). Based on evidence from both lesion studies and brain imaging studies, I will conclude that it is plausible that semantic knowledge is represented in a distributed fashion with a 'hub' (possibly located in the ATL) where information is integrated to form coherent and exact semantic concepts.

2. Lexical and semantic access

One way to learn about the mental representations of semantic knowledge in healthy populations is through lexical access tasks, because they inform us what facilitates and inhibits access. The robust findings of priming effects, for example, seem to indicate that words which are associated with each other – either phonologically or semantically – are also organised in a similar fashion since activating one facilitates access to the other (e.g. Meyer & Schvaneveldt, 1971). I will here describe two common lexical access tasks; the word naming task and the lexical decision task.

In the word naming task, participants are presented with a quick succession of words and asked to read them out loud, and their performance is measured by accuracy and reaction time. In this task, phonotactically legal pseudo-words do not take longer to name than regular words, which seems to indicate that there is actually no semantic access here, only interaction between orthography and phonology. Yet, when the word presented is part of the lexicon but spelled in an irregular way, it is still pronounced correctly and quickly, indicating that there is access to lexemes if not semantic knowledge (e.g. Lorch, Balota, & Stamm, 1986). In the lexical decision task, participants are asked to judge, as quickly and accurately as possible, whether a word presented is an actual word or not. In both the word naming task and the lexical decision task, there are several interesting factors affecting how well lexical access is achieved. I will only go through the effects relevant to the representation of semantic knowledge. First, frequent words are retrieved more quickly than similar, less frequent words (e.g. Whaley, 1978). Second, words acquired at an earlier age are retrieved more quickly than similar words acquired later (e.g. Barry, Morrison, & Ellis, 1997). Third, in the lexical decision task, pseudo-words are the type of words that take the longest time to reject (e.g. Coltheart et al., 1977). Finally, and perhaps most interestingly as it taps into actual semantic knowledge, if a certain category of words is primed, words belonging to this category are accessed more quickly and more accurately. For example, "doctor" primes "nurse" but not "tree" (e.g. Antos, 1979). Frequency effects,

age-of-acquisition effects, pseudo-word legality effects and priming effects all give us an indication as to how semantic knowledge is accessed. In the following, I will explore two different types of early models of how semantic knowledge might be stored and accessed, and how these models explain the effects described above.

There are primarily two types of models of lexical access – parallel and serial. One of the first of these models was the logogen model, a parallel access model proposed by Morton (1969). It is now quite outdated, but it provides a good context for how we might understand lexical access and storage. In the logogen model, there is a locus of representation for each word, and these loci are called logogens. When we receive sensory information – any sensory information, although different versions of the model disagree on whether both access and logogens are modality-specific – the cognitive system processes the input and feeds it in parallel to all the entries present in our mental lexicon. Logogens can be thought of as feature detectors, and once a logogen has detected enough features that are consistent and exceed some threshold, the logogen 'fires'. The first logogen that gets enough information to trigger it is accessed. This accounts for some of the empirical effects, for example the frequency effect (because frequent words have lower thresholds) and pseudo-word legality (because these words elicit partial activation of many similar logogens). A second influential model of lexical access is the serial search model, proposed by Forster (1976). In this model, the brain responds to a heard or read word by producing a perceptual representation which then accesses a lexical store in list-format. These 'lists' are organized as a set of bins in which words are sorted in order of frequency. Lexical and semantic access is achieved by searching via either a phonological, orthographic, or syntactic/semantic path until a visual or auditory match to the representation from the check-in stage is found. This access 'file' yields access to all other information about the word (such as category and representations in all sensory modules). Illegal non-words cannot access any bins while pseudo-words have to go through the entire bin before they can be rejected. The priming effect is explained by the use of a special semantic bin where the contents change according to the primed category. Although the

models described above can account for many of the access effects in healthy participants, the issue of how semantic knowledge is stored beyond lexical access can be further illuminated with evidence from patients with brain damage – in the following, I will explore further notions of how semantic knowledge is accessed in this context.

2.1. Modality of access

One interesting question to ask – which has also been addressed by the models described above – is whether access to semantic knowledge is amodal, that is whether information from different sensory modalities access the same semantic system. This notion has been contested, and some researchers have instead proposed a multi-modal model (e.g. Paivio, 1971). Here, there are separate verbal and visual conceptual systems, and evidence is provided from several studies of patients with selective deficits in visual and verbal access pathways to meaning. For example, in Bub et al. (1988), patient MP showed very poor comprehension of verbal material and did not show automatic semantic priming, but did show much better comprehension of the meaning of pictures. MP was able to say that a banana was yellow from a black-and-white line drawing although he could not name it, which indicates that he had intact semantic knowledge about bananas and that he had a deficit at a different level in the access pathway. There is further evidence from modality-specific anomia, where patients have a naming disorder in only one modality – for example, in the disorder known as optic aphasia, patients are impaired with naming objects presented visually, but can name them when exposed to the objects in other modalities, for example by sound or touch (e.g. Beauvois, 1982). Furthermore, these patients have no general visual agnosia. This means that the names and meanings of objects are still intact, which seems to indicate that only the visual pathway to the semantic store is disrupted. The findings from Bub et al. (1988) do not necessarily entail that we have different semantic stores for each sensory modality – it is possible that it was merely patient MP's verbal access pathway was disrupted and not his 'verbal store'. In the following, I will discuss how semantic knowledge could be

stored using evidence from semantic dementia, a neurodegenerative disorder which causes impaired picture and word recognition.

3. Storage

In the context of storage of semantic knowledge, it is useful to look at semantic dementia, which is a disorder characterised by loss of semantic knowledge in both verbal and visual domains and atrophy primarily in the anterior temporal lobe. Evidence from priming experiments and the fact that children show preference for category organisation of newly acquired concepts (taxonomic bias – see for example Markmann & Hutchinson, 1984) seems to indicate that our semantic knowledge is at least to some extent organised according to categories. Evidence from some semantic dementia patients with interesting selective semantic category deficits can help further explain this notion. Including data from semantic dementia patients is particularly important because it might be informative as to how healthy brains organise objects in categories based on a variety of similar and distinguishing features. Some particularly interesting dissociations where one type of words is impaired while the other is spared are high versus low frequency (Warrington & Shallice, 1984), abstract versus concrete (Jefferies et al., 2009), and man-made versus living (e.g. Damasio et al., 2004). In the following, I will focus on the man-made versus living dissociation, which has sparked much controversy in the literature (see Capitani et al., 2003, for a critical review).

The selective deficit of either animate or inanimate objects, also known as the living/non-living distinction, is one of the most interesting and widely attested dissociations in semantic impairment (see Caramazza & Shelton, 1998). It is interesting because, if true, it means that these two categories are stored in different places in the brain, and we can start mapping out the mental lexicon. However, it is more likely that the difference is mediated by the fact that members of each category share some other, more abstract property. One influential theory about why we seem to have the living/non-living distinction

concerns how brain function is divided into motor and perceptual representation (see Martin, 2007). According to this theory, different parts of the brain process functional representations (e.g. tools, and how they can be used) and integrated, perceptual features (necessary for distinguishing animals). Early PET imaging studies using healthy participants suggested that knowledge about animals and tools is indeed stored in separate, identifiable parts of the brain (Martin et al., 1996). In this study, naming animals activated the left medial occipital lobe, a region involved in the earliest stages of visual processing. In other words, participants appeared to be evoking the appearance of the animal in naming it (note that they were given visual input in both the animal- and tool-naming tasks). In contrast, naming tools activated a left premotor area also activated by imagined hand movements and an area in the left middle temporal gyrus also activated by the generation of action words. One plausible explanation for this could be that animals require feature processing for identification while tools only require function.

4. Integrating features

Semantic dementia patients have specific trouble integrating features and forming coherent concepts – one theory, which I will return to later, is that this could be connected to their specific atrophy in the ATL (Patterson, Nestor, and Rogers, 2007). Evidence for the idea that feature integration and sensitivity to specificity is located in the anterior frontal lobe comes primarily from comparing patients with semantic dementia and patients with Alzheimer's disease. Both these dementias are characterized by gradually increasing atrophy of brain tissue, but they affect different areas of the brain. As mentioned, patients with semantic dementia have atrophy especially in the anterior temporal lobe, and they show specific deficits in processing semantic knowledge which are not present in patients with Alzheimer's disease. For example, in Patterson, Nestor, and Rogers (2007), the researchers describe how patients with severe semantic dementia are unable to process unusual features of objects, for example telling whether a

pumpkin should be orange or not (because vegetables are usually green), and whether an elephant with small ears is a real animal. They also had difficulties reproducing drawings of animals after a delay, tending to simplify the animals and make them more generic (e.g. removing the hump of a camel and giving a duck four legs). This seems to indicate that the patients have preserved broad semantic categories but have problems integrating the specific features to distinguish and remember subtypes, which is consistent with the hypothesis that feature integration occurs in the anterior temporal lobe. Semantic dementia patients also gradually become worse and worse at naming specific things as the disease progresses – for example, they cannot name a chicken, but retain the overall "animal" category longer.

4.1. The hub

Many current theoretical positions about semantic memory share the view that much of the content of our semantic memory relates to perception and action, and is represented in brain regions that overlap with, or possibly even correspond to, the regions that are responsible for perceiving and acting (Kiefer & Pulvermüller, 2012). This view about the neural representation of how objects look, sound, move and so on therefore entails commitment to the idea that conceptual knowledge is a widely distributed neural network. However, Patterson, Nestor, and Rogers (2007) challenged the idea of semantic knowledge as being a distributed-only network. They argued that too much of semantic processing depends on integrating cross-modal features and comparing different objects' features. With regard to the living/non-living distinction, they state that there is considerable debate in the literature as to whether these two domains of conceptual knowledge are represented separately in the brain, or whether this dissociation can be explained by some fundamental difference in the nature of the attributes that are characteristic of man-made and living things. The researchers propose that there is a hub which integrates the features of objects, and that this hub is located in the anterior temporal lobe, drawing on the evidence from semantic dementia patients discussed above. Later studies using transcranial magnetic stimulation (TMS) on

healthy participants confirmed that disrupting ATL function impairs performance similar to the deficits found in semantic dementia (Pobric et al., 2010).

5. Conclusion

In conclusion, lexical access tests have informed us that words that are frequent and acquired early in life are quicker to access, and the effect of semantic priming indicates that words are stored in associative categories. More research is needed to determine whether frequency and age-of-acquisition effects extend beyond a lexical level to a semantic level – for example, it would be informative to test if similar effects are also found with non-verbal access to semantic knowledge. Evidence from both brain imaging studies and lesion studies have shown that semantic knowledge is probably widely distributed and can be accessed from different sensory modalities. It seems plausible that semantic knowledge is organized differently according to whether an object's primary feature is its function or if it is its perceptual features. If one is trying to name a hammer, it is enough to know what it does. If one is trying to name a monkey, one has to integrate all the features that pertain to this and only this type of animal living in the jungle. Evidence from semantic dementia patients informs us that the integration of features from different modularities and the mechanisms of precise categorization probably take place in the anterior temporal lobe. I therefore conclude that there is some support for the idea that semantic knowledge is represented in a distributed fashion with a hub possibly located in the ATL for integrating features and forming coherent concepts. It is important to note that there is still a long way to go before we understand the relative contributions of the hub versus the distributed network to the overall semantic representation, as well as how they interact in the process of settling on a stable semantic representation. For example, it would be useful to study whether these semantic dementia patients also have difficulties combining access to meaning from a visual input to

the same meaning represented in another modularity (e.g. matching the image of a duck to the sound of a duck).

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UNIVERZITET U NOVOM SADU,
FILOZOFSKI FAKULTET NOVI SAD,
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