

THE INFLUENCE OF THE EXPERIMENTAL CONTEXT ON LEXICAL AMBIGUITY EFFECTS

Ksenija Mišić^{1*}, Dušica Filipović Đurđević²

¹University of Belgrade, Faculty of Philosophy,
Laboratory of Experimental Psychology, Belgrade, Serbia

²University of Belgrade, Faculty of Philosophy, Department of Psychology,
Laboratory of Experimental Psychology, Belgrade, Serbia

Abstract

Previous research with the visual lexical decision task demonstrated that polysemous words (multiple related senses) have a processing advantage when compared to unambiguous words, whereas homonymous words (multiple unrelated meanings) have a processing disadvantage. Although the same pattern of results was observed in Serbian, the two effects were investigated in separate studies. The aim of this study was to test whether the effects can be replicated when both types of ambiguity are presented within the same experimental list. To test this, we conducted three experiments. In the first one, the mixed presentation of unambiguous, homonymous, and polysemous words did not reveal any of the ambiguity effects, leading to the conclusion that the experimental context may affect the emergence of ambiguity effects. The other two experiments were conducted to explicitly control for the experimental context. In both experiments, we presented each ambiguity type within the same block and counterbalanced the order of the block presentation. These experiments revealed the presence of the polysemy advantage, but not the homonymy disadvantage, which is a common pattern in literature. Polysemy effects typically emerge relatively easily, whereas the homonymy disadvantage requires additional conditions. Finally, we conclude that experimental context does play a role in ambiguity processing, although the order of presentation does not affect the overall results.

Key words: lexical ambiguity, polysemy, homonymy, experimental context

* Corresponding author: Ksenija Mišić, University of Belgrade, Faculty of Philosophy, Laboratory of Experimental Psychology, Čika Ljubina 18-20, 11000 Belgrade, Serbia, ksenija.misic@f.bg.ac.rs

УТИЦАЈ ЕКСПЕРИМЕНТАЛНОГ КОНТЕКСТА НА ЕФЕКТЕ ВИШЕЗНАЧНОСТИ РЕЧИ У СРПСКОМ ЈЕЗИКУ

Апстракт

Претходна истраживања са задатком визуелне лексичке одлуке показала су да се полисемичне речи (више повезаних значења) обрађују брже од једнозначних речи, док се хомоними (више неповезаних значења) обрађују спорије. Према је исти склоп резултата забележен и у српском језику, ови ефекти су забележени у одвојеним експериментима. Циљ овог рада био је да се испита да ли се ови ефекти могу поновити када се обе врсте вишезначности налазе у оквиру исте експерименталне листе. Како би се то тестирало, изведена су три експеримента. У првом експерименту није забележен ниједан од ефеката вишезначности, што је довело до закључка да експериментални контекст може утицати на ефекте вишезначности. Друга два експеримента су настојала да додатно контролишу експериментални контекст. У оба експеримента, свака врста вишезначности је приказана унутар једног блока, а редослед излагања блокова је био контрабалансиран. У оба случаја је забележен ефекат полисемије, међутим ефекат хомонимије није, што је уобичајени склоп резултата у литератури. Ефекти полисемије се уобичајено јављају релативно лако, док су за јављање ефеката хомонимије потребни посебни услови. Коначно, можемо закључити да експериментални контекст утиче на обраду вишезначних речи, мада редослед излагања не утиче на типично забележене резултате.

Кључне речи: вишезначност речи, полисемија, хомонимија, експериментални контекст

INTRODUCTION

Lexical Ambiguity

Lexical ambiguity is a very frequent linguistic phenomenon, in which one orthographic/phonological form may have different semantic realisations. In Serbian, multiple categories of words with multiple semantic realisations exist (Dragičević, 2010; Gortan-Premk, 1984, 2004; Tafra, 1986).

Polysemous words are words with *multiple related senses*, such as the word *glava*, which can denote both a body part and a person leading a group of individuals (amongst other senses). Polysemes emerge in language by expanding the semantic field of a word to similar referents (Gortan-Premk, 2004). The semantic field expands by means of multiple mechanisms (Dragičević, 2010) – metaphor, metonymy, synecdoche, and platysemy. Briefly, metaphor is a mechanism of expanding a lexeme to different senses by the means of similarity between two (or multiple) referents (e.g., wing of a bird and wing of a plane). Metonymy, unlike metaphor, is not based on similarity, but occurs between senses belonging to the same domain, wherein the connection between two senses is more literal. The usual example of metonymy is the relationship between the entirety of the referent and its element (e.g., lamb as an animal and lamb as

meat). Other mechanisms are less frequent. One is synecdoche, a mechanism similar to metonymy, where a lexeme is transferred from a part to the entirety of the referent (e.g., a head of the committee representing the person that is leading the committee). The other is platysemy (Grickat, 1967), a lexical mechanism first described in Serbian, wherein the differences between referents are more subtle than those related to other mechanisms that expand the semantic field of a lexeme. Additionally, platysemy is a mechanism more related to verbs or adjectives (e.g., a strong man, a strong will, a strong wind, etc.). Finally, similisemy (Gortan-Premk, 2003; 2018), a mechanism similar to platysemy, has been described to account for the phenomenon of words denoting analogue body parts in humans and various animals (e.g., head of a man, head of a bird). Therefore, it is apparent that polysemy is a systematic phenomenon, which appears as a consequence of a number of linguistic mechanisms. Polysemous words are also the most frequent type of ambiguity, making up approximately 80% of corpora in multiple languages. In Serbian, in just a small sample of the dictionary, a significant number of polysemes with over fifteen senses was counted (Dragičević, 2010).

Homonymous words are words with *multiple unrelated meanings* (Dragičević, 2010), such as the Serbian word *pop*, which denotes both a clergyman and a music genre. Unlike polysemes, homonyms appear in language as a random phenomenon. Some of the causes of the homonymous relationship between two meanings are: accidental occurrence of two orthographic forms of semantically unrelated words matching a shared form between words of unrelated meanings, which comes about accidentally (e.g. when one of the meanings is taken from another language, as in our example); splitting polysemous structures (word formation, acronyms matching the form of already existing word); phonetic changes; attraction (although very rarely); and etymological errors. However, there are some slight variations within homonyms as a group. In addition to *full homonyms*, where meanings are mutually exclusive and contextually infungible (Tafra, 1986), but share an orthographic and phonological form, there are some subtypes of homonymy where different semantic realisations do not necessarily share other forms (Dragičević, 2010). *Homographs* are words that, besides semantic differences, also differ in their phonology, but share the same orthographic form. An example of this is the word *grad* which can denote both a large, populated area and a form of solid precipitation. The two instances differ in stress (*grād* and *gräd*, respectively). *Homophones*, similarly, vary in semantic and orthographic forms, whilst keeping the phonological form constant. These, however, rarely appear in Serbian due to the highly transparent orthography of the language. *Homomorphs* (Dragičević, 2010; also known as *homophorms*) are words which share some of their grammatical forms, but not all. An example of this may be the word *radio*. It refers to

both wireless communication through electromagnetic waves and the past tense of a verb *raditi* (*to work*). Even though these types of ambiguity share some of the features of homonyms, they are considered just a similar phenomenon and need to be treated separately.

Ambiguous Words Processing

Although there are multiple variants of ambiguity, this paper focuses on polysemy and homonymy, variants which are often referred to in literature as “semantic ambiguity” (Eddington & Tokowicz, 2015). These two types are especially important because the properties of the two ambiguity types are the same in regards to their orthographic and phonological forms, and different only in regards to their semantic representations (Cruse, 2000, Taft, 1986). Therefore, these two types of ambiguity represent excellent probes into the mental representations of semantics, as they are two extremes of the continuum of the relatedness of the senses/meaning of ambiguous words, without non-semantic cues for disambiguation (such as accent, part of speech etc.).

Research on semantic ambiguity processing and mental representations started within the research on storing words with multiple meanings in the mental lexicon. The results on how these words were processed were mostly inconclusive (Eddington & Tokowicz, 2015). Later research started relying on long known categorizations from semantics (Allan, 2009; Lyons, 1977) and took into account the complexity within the lexical ambiguity phenomenon. Separating ambiguity into polysemy and homonymy revealed a *relatedness effect*. Related senses of polysemes facilitated processing or, in other words, led to *polysemy advantage*, whereas unrelated meanings made processing slower and more difficult – *homonymy disadvantage* (Azuma & Van Orden, 1997; Klepousniotou, 2002; Rodd et al., 2002). This pattern of results was explained by postulating two different mechanisms by which meaning/sense representations are interconnected. According to this view, upon the presentation of a word, all possible meanings/senses are activated, although commonalities between polysemous senses allow cooperation, while differences in homonymous words’ meanings lead to competition. Multiple modelling efforts managed to confirm these dynamics (e.g., Armstrong & Plaut, 2016; Rodd et al., 2004;), with varying accuracy rates.

Research that followed further established this opposite pattern of results, while exhaustively examining the different factors that affect processing, such as the degree of relatedness among the referents (metaphor/metonymy), number of meanings/senses, meaning/sense dominance, differences in distribution of meaning/sense probabilities, parts of speech, etc. (Armstrong & Plaut, 2016; Eddington & Tokowicz, 2015; Filipović

Đurđević, 2019; Filipović Đurđević & Kostić, 2008, 2017; 2021; Hino et al., 2002, 2006, 2010; Klepousniotou et al., 2008, 2012; Klepousniotou & Baum, 2007; Lopukhina et al., 2018; Mišić & Filipović Đurđević, 2021; Rodd, et al., 2002; Rodd, 2020). We must note that the research presented thus far pertains to words presented in isolation, because some of these effects are not present when a word is presented within a biasing context. Although the existing work reveals differences in ambiguity resolution for homonyms and polysemes (Armstrong & Plaut, 2016, appendix; Edgington & Tokowicz, 2015), this exceeds the scope of this paper, and will not be discussed further.

The theories that explain a number of the aforementioned findings can roughly be divided into two groups: the response system account (or decision-making account) and semantic competition accounts. The response system account (Hino et al., 2006, 2010) postulates that lexical ambiguity effects arise in the process of response selection as a consequence of the task-specific strategies and the amount of evidence provided by semantics for a particular response (so called feedback semantics). Therefore, these models do not necessarily predict the opposite pattern of polysemous and homonymous word. They state that the amount of semantic evidence is not modulated only by the semantic relatedness of referents, but also by task demands. However, many findings do not agree with this, and the model has been criticised for its many post hoc explanations and for being overly flexible (Armstrong & Plaut, 2016). Semantic competition accounts (e.g., Armstrong & Plaut, 2016; Rodd et al., 2004) rely on cooperation and competition mechanisms that underlie polysemy advantage and homonymy disadvantage. In other words, these theories pertain to the relationships between sense/meaning representations and rely on that knowledge to predict the ambiguity effects. The latest iteration of the semantic competition accounts (Armstrong & Plaut, 2016) relies on its aforementioned predecessor in relation to the difficulties of simulating two opposite processes (cooperation and competition) for the two extremes of the sense/meaning relatedness continuum. In addition to that, Armstrong and Plaut's model describes the temporal dynamics of the two processes throughout the duration of processing.

The Present Research

When tested on Serbian nouns, both polysemy and homonymy exhibited the expected advantage and disadvantage effects. Compared to unambiguous words, when presented as part of the visual lexical decision task, polysemous words were processed faster (Filipović Đurđević & Kostić, 2008; 2021; Mišić & Filipović Đurđević, 2021), and homonyms were processed slower (Filipović Đurđević, 2019; Mišić & Filipović Đurđević, 2019). However, both types of ambiguity have previously

never been tested in the same experiment, as they were traditionally contrasted (cf. Klepousniotou, 2002; Rodd et al., 2002). Therefore, our main aim was to perform a conceptual replication of the polysemy advantage and homonymy disadvantage effects in a single experiment in Serbian. We wished to contrast the two opposite effects that polysemes and homonyms have on processing within one experimental context in Serbian. In order to test this, we conducted three experiments. Based on previous findings, we expected to observe polysemy advantage and homonymy disadvantage.

EXPERIMENT 1

Experiment 1 was conducted to test the presence of both polysemy advantage and homonymy disadvantage in the same experimental context. Three groups of words, polysemous, homonymous and unambiguous words, were presented within the same task.

Method

Participants. Thirty-nine psychology students from the University of Belgrade Faculty of Philosophy, Department of Psychology participated in this study for course credits. All were native Serbian speakers and had normal or corrected-to-normal vision. The study was approved by the institutional review board and the data was collected in 2015.

Stimuli. Word stimuli were selected from the six volumes of the *Serbo-Croatian standard language dictionary*¹ (1967 – 1976), as well as published polysemy norms (Filipović Đurđević & Kostić, 2017) and homonymy norms (Filipović Đurđević, 2019). Stimuli presented to the participants were 35 polysemous words (e.g., *grudi*), 35 homonymous words (e.g., *sud*), and 35 unambiguous words (e.g., *ponoć*), a total of 105 stimuli. The three word groups were matched by controlling for lemma frequency, familiarity, and concreteness (all p 's > .05). The difference in word length (in letters) between groups was statistically significant, although numerically negligible, since the average word length per group did not differ by more than two letters (Table 1). The number of meanings/senses was determined in a norming study in which participants listed meanings/senses for words assumed to be homonymous/polysemous based on the dictionary (Filipović Đurđević & Kostić, 2017 for polysemous words; Filipović Đurđević, 2019 for homonyms). In addition, 105 pseudowords were presented in the task. Therefore, the total number of stimuli in the experiment was 210.

¹ *Rečnik srpskohrvatskoga književnog jezika*

Table 1. Descriptive statistics of word stimuli

	Homonyms		Polysemes		Unambiguous	
	M	SD	M	SD	M	SD
Word length ^a	3.86	.94	5.23	.81	4.60	1.19
Frequency ^b	75.95	125.64	81.49	144.85	81.15	107.65
Familiarity ^c	5.79	.90	6.05	.43	5.88	1.01
Concreteness ^c	5.26	1.41	4.90	1.50	5.18	1.71
NoS/NoM ^d	2.97	1.01	2.97	1.01	-	-

a – in letters, b – per 2 million (Kostić, 1999), c – estimated on a seven-point Likert scale (Filipović Đurđević, 2019; Filipović Đurđević & Kostić, 2017), d – estimated in a norming study (Filipović Đurđević, 2019; Filipović Đurđević & Kostić, 2017).

Design. The experiment followed a 2×3 factorial design, with both factors being within-subject. One of the factors was lexicality (word/nonword) and the other was ambiguity (polysemes/homonyms/unambiguous). Additionally, we controlled for the trial order of presented stimuli. The dependent variable was reaction time, measured in milliseconds and error rates for participants and stimuli.

Procedure. The visual lexical decision task was run in *OpenSesame 3.0* software (Mathôt et al., 2012). Each trial began with the presentation of a fixation cross (1000ms) and a blank screen (500ms), followed by stimuli, each of which remained on screen until the participants' response, with a maximum duration of 1500ms. If the presented stimulus was a word, participants were instructed to press 'm' on the keyboard, or press 'c' in case of a pseudoword.

Before the participants began the experimental block, they went through a short practice session, during which 9 words (3 for each level of ambiguity factor) and 9 pseudowords were presented. The stimuli within each block were presented in a random order. Reaction times measured in practice trials were not included in the analysis.

Results

Participants and stimuli with an accuracy rate of less than 75% were removed from the dataset. Thus, eight nouns (five of which were unambiguous, three homonymous) and the data gathered from one participant were removed from the dataset. Additionally, reaction times pertaining to incorrect responses were removed from the dataset. In total, approximately 14% of the original data was removed prior to analysis.

The data was analysed in R statistical software (R Core Team, 2018) by Linear Mixed Effects Regression analysis (Baayen et al., 2008), using the *lme4* (Bates, Mächler, et al., 2015) package. Results were plotted in the *ggplot2* package (Wickham, 2016).

Reaction times were inversely transformed ($-1000/RT$; Baayen & Milin, 2010) in order to resemble normal distribution. Trial order was included in the analysis to control for fatigue or practice effects (Baayen & Milin, 2010) and was transformed to z-scores (Gelman & Hill, 2007).

Fixed effects consisted of the trial order and the three-level ambiguity factor. The effect of ambiguity was treatment contrast coded (Schad et al., 2020), with unambiguous words set as the reference level. The random effects structure was specified by following the recommendations of keeping the key interactions and the key predictors as random effects if such models reached convergence (Barr et al., 2013). In order to avoid over-parametrization, the *rePCA* function (*RePsychLing* package; Bates, Kliegl, et al., 2015) was used as a diagnostic tool to remove random effect parameters that were not supported by the data. The final random effects structure consisted of random intercepts for both participants and stimuli, and random participant slopes for the trial order. The correlation parameter for random slopes for the trial order was dropped due to the correlation being estimated near zero ($\rho = -.08$; Bates, Kliegl, et al., 2015, p. 7). Data points with residuals larger than ± 2.5 SD were removed, and the model was refitted.

The final model revealed no ambiguity effects whatsoever (Table 2). Both polysemy and homonymy showed no differences in processing when compared to unambiguous words. Also, no trial order effect was found, likely due to the length of the experiment not being sufficient for practice or fatigue effects to emerge.

Table 2. Summary of the mixed effect model with inverse RT as dependent variable, and ambiguity type and trial order as predictors.

<i>Random effects</i>					
	Variance	SD			
Items (Intercept)	.016	.126			
Subject (Intercept)	.032	.179			
Residual	.062	.249			
<i>Fixed effects</i>					
	Coefficient	S.E.	df	t	p
Intercept (Ambiguity: Unambiguous)	-1.646	.038	88.48	-43.567	<.001
Trial order	-.061	.004	3312.00	-1.416	.157
Ambiguity: Homonymy	.008	.034	95.20	.249	.804
Ambiguity: Polysemy	.004	.033	95.01	.128	.898

Discussion

In Experiment 1, we tested for lexical ambiguity effects, i.e., polysemy advantage and homonymy disadvantage, within the same experimental context. Our prediction was based on the fact that the two effects

had previously been demonstrated separately (Filipović Đurđević, 2019; Filipović Đurđević & Kostić, 2008; 2021). However, no ambiguity effect whatsoever was found in this experiment. A possible cause of the vanishing of the effects is the presentation of the words in a randomised order within the same experimental context. Considering the inconsistent detection of homonymy disadvantage throughout literature (Armstrong & Plaut, 2016; Eddington & Tokowicz, 2015), the lack of that effect in this experiment was less surprising. However, polysemy advantage was routinely detected (Armstrong & Plaut, 2016; Rodd et al., 2002), even when homonymy disadvantage was not. This led us to hypothesize that methodological factors may be the reasons for not detecting such a robust effect. This was further motivated by these effects being present when tested separately in Serbian (Filipović Đurđević, 2019; Filipović Đurđević & Kostić, 2008; 2021). In order to test whether mixing of ambiguity types was truly the cause of the null effects, we conducted the second experiment.

EXPERIMENT 2

Experiment 2 was conducted to test whether the order of presenting polysemous and homonymous words was the cause of the lack of expected effects. Therefore, the aim was to test whether the order in which one encounters different types of ambiguity may affect processing. Thus, we controlled for the presentation order for the same stimuli used in Experiment 1. Instead of a randomised presentation of three word groups, we presented each group within one block. Our main comparison centred on whether or not the polysemous word block appeared before the homonymous one. Therefore, we tested two possible orders, with the addition of the unambiguous word block as the control group. The unambiguous block could be placed at the beginning or at the end of the experiment so that the two ambiguous word blocks could appear one after the other. This allowed us to explicitly test whether the ambiguity type presented first may affect the processing of the type presented afterwards.

Method

Participants. Fifty-four first year students from the University of Belgrade – , Faculty of Philosophy, Department of Psychology took part in the experiment for course credits. All had normal or corrected-to-normal vision and were native Serbian speakers. The study was approved by the institutional review board and the data was collected in 2015. No participants from Experiment 1 took part in this experiment.

Stimuli and design. The same stimuli used in Experiment 1 were used in this experiment. This experiment followed a factorial $2 \times 3 \times 2 \times 2$

design. The factors were lexicality (word/pseudoword), ambiguity (homonymous – H / polysemous – P / unambiguous - U), the order of ambiguous blocks (homonymy then polysemy / polysemy then homonymy) and unambiguous word position (beginning / end position). Combining the latter two factors, resulted in four different block orders – HPU, UHP, PHU, UPH. The lexicality and ambiguity factors were manipulated within the participants, whereas the ambiguous block order was manipulated between participants. The dependent and control variables remained the same as in Experiment 1.

Procedure. The task was the same as in Experiment 1, with differences in the presentation order of different types of ambiguity. Instead of fully randomised presentation of stimuli, they were presented within blocks, both in the warm-up section of the experiment, as well as the main section of the experiment. Blocks would consist of only one group of words (homonymous, polysemous, or unambiguous). Within each block, words were presented in a random order. The order of the blocks was counterbalanced, which resulted in the list of structures presented in the *Stimuli and design* section. Participants were randomly assigned to only one of the four lists.

Before the experimental trials, participants were presented with warm up trials. The structure of the practice block reflected the order of blocks in the experimental part, each block containing three stimuli and nine pseudowords overall. Reaction times measured in practice trials were not included in the analysis.

Results

Data preprocessing and analyses were conducted following the same procedure as in Experiment 1. During preprocessing, 17% percent of the original dataset was removed, including two participants, and 12 stimuli (6 homonyms, 5 unambiguous and 1 polysemous word). The final model included random intercepts for participants and stimuli as random effect parameters. Fixed effect parameters included ambiguity and order of the homonymy and polysemy blocks. Both were treatment contrast coded with the reference level being unambiguous word and homonyms, and polysemous block order, respectively. Additionally, trial order was included to control for possible practice or fatigue effects.

The final model result summary is presented in Table 3. Once again, trial order did not reveal any effects in this experiment. However, we observed an interaction between block order and ambiguity type. Polysemy advantage and homonymy disadvantage were absent when the block of homonyms was presented first. On the other hand, while homonymy disadvantage was still absent, polysemy advantage was marginally significant in the order in which polysemes were presented first (Figure 1). The inclusion

of the position of the unambiguous word block as a factor and the three-way interaction was not justified by the data.

Table 3. Summary of the mixed effect model with inverse RT as the dependent variable, and ambiguity type, block order, and trial order as predictors.

<i>Random effects</i>					
	Variance	SD			
Items (Intercept)	.013	.114			
Subject (Intercept)	.025	.158			
Residual	.048	.219			

<i>Fixed effects</i>					
	Coefficient	S.E.	df	t	p
Intercept (Unambiguous, PH)	-1.577	.038	125.50	-41.885	.000
Trial order	-.002	.004	5483.00	-.570	.569
Homonymy	.011	.032	108.80	.356	.723
Polysemy	-.039	.031	109.60	-1.270	.207
PH	.013	.041	71.09	.320	.750
Order HP: Homonymy	.007	.016	5481.00	.453	.651
Order HP: Polysemy	.025	.015	5481.00	1.650	.099

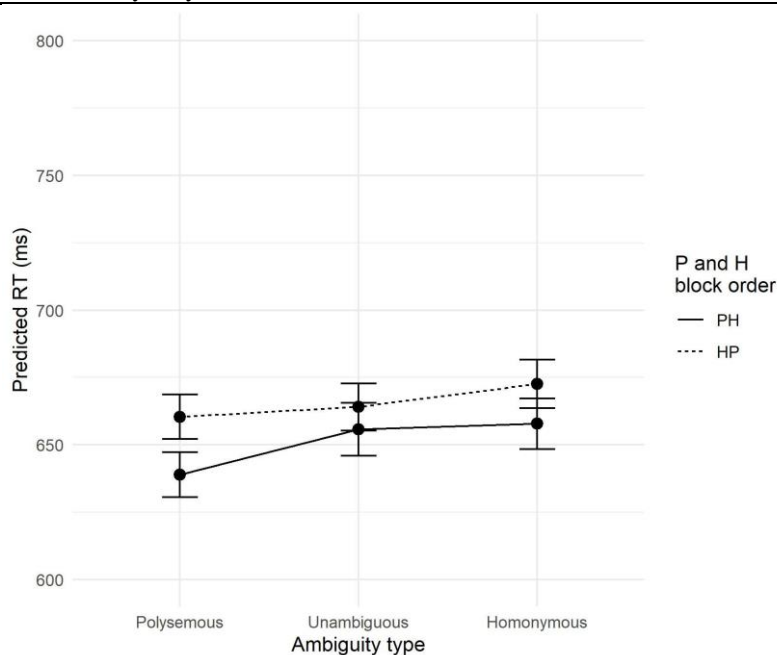


Figure 1. The interaction between ambiguity type and the polysemous and homonymous block order in Experiment 2

Discussion

The second experiment revealed some trends when compared with the randomly presented and mixed ambiguous words in the first experiment. The emergence of a marginal polysemy effect when polysemous words are presented first suggests that presentation order may play a role in the absence of these effects. The task effects on ambiguity processing have been extensively explored in literature (Armstrong & Plaut, 2016; Azuma & Van Orden, 1997; Hino et al., 2002; Rodd et al., 2002). In order to further explore this variability of effects as a consequence of methodological decisions, such as presentation order, we conducted a third experiment.

EXPERIMENT 3

The aim of Experiment 3 was twofold. The first aim was the replication of the findings from Experiment 2. The second aim was to expand the design to try to include the interrupted orders of presentation of ambiguous blocks, wherein the unambiguous block were to be placed between the two ambiguous blocks. This would allow us to see whether the pattern would remain the same in a separate participant sample, and whether any effects would emerge after a break between a polysemous block and a homonymous block.

Method

Participants. Eighty-one participants took part in the experiment. All were first year students from the University of Belgrade, Faculty of Philosophy, Department of Psychology. Participants were native Serbian speakers and had normal or corrected-to-normal vision. The study was approved by the institutional review board and the data was collected in 2016. No participants from Experiments 1 and 2 took part in this experiment.

Stimuli and design. The same stimuli from Experiments 1 and 2 were used in this experiment. In Experiment 3, we included another level of the unambiguous words position factor, in the middle of the homonymous and polysemous blocks, making the design 2x3x2x3. The two additional block orders which were the result of this addition were the PUH and HUP orders. Again, lexicality and ambiguity were manipulated within participants, whereas ambiguous block order was manipulated between participants. All other aspects of the design remained the same.

Procedure. The experimental procedure remained the same as in Experiment 2, with the addition of two more block orders (see *Stimuli and design* section).

Results

Data preprocessing and analyses were conducted following the same procedure as in Experiment 1. We discarded 13% of the original dataset. No participants were excluded, while nine words were (3 homonyms, 5 unambiguous words, and 1 polysemous word). The final model included the trial order, ambiguity type, and the order of the homonymous and polysemous blocks. Both categorical predictors were treatment contrast coded. The reference level for ambiguity type were unambiguous words, and for homonymy/polysemy order, the reference was the HP order.

The analysis (Table 4) revealed an interaction between the ambiguity type and the HP order. In both orders, the polysemy effect was present, whereas the homonymy effect was absent (Figure 2). The trial order revealed a small practice effect during this experiment. The three-way interaction between the ambiguity, homonymy and polysemy block order, and the position of unambiguous words were not justified by the data. The data did not justify the inclusion of the unambiguous block position factor either.

Taking into consideration the fact that the polysemy effect, which is typically stable, was present here and not in the second experiment, we ran the analysis on the two experimental conditions that were the only difference between the third and the second experiment (PUH, HUP). This analysis only revealed a polysemy effect in cases in which the polysemous block was introduced first.

Table 4. Summary of the mixed effect model with inverse RT as the dependent variable, and ambiguity type, HP order, and trial order as predictors.

<i>Random effects</i>					
	Variance		SD		
Items (Intercept)	.014		.117		
Subject (Intercept)	.029		.169		
Residual	.049		.222		
<i>Fixed effects</i>					
	Coefficient	S.E.	df	t	p
Intercept (Unambiguous, PH)	-1.461	.035	163.20	-41.608	.000
Trial order	-.013	.003	7101.00	-3.747	.000
Homonymy	.024	.031	106.30	.761	.448
Polysemy	-.069	.031	106.00	-2.231	.028
HP	-.057	.039	87.74	-1.472	.145
Order HP: Homonymy	-.029	.014	7100.00	-2.038	.042
Order HP: Polysemy	.032	.014	7099.00	2.335	.020

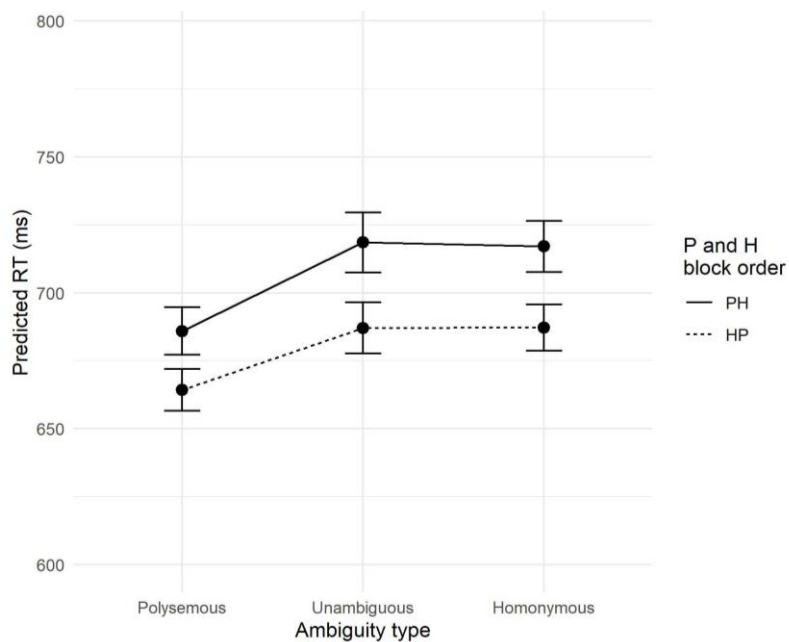


Figure 2. The interaction between the ambiguity type and the polysemous and homonymous block order in Experiment 3

Discussion

The third experiment in this series was conducted with the goal of testing all possible orders of the three blocks. Two more orders were added to the third experiment, both having a block of unambiguous words interrupting ambiguity blocks, i.e., HUP and PUH blocks. The results revealed polysemy advantage in both ambiguous block orders, while homonymy disadvantage was, once again, absent. Firstly, the appearance of polysemy advantage in this experiment and not in the previous one, raised the question of whether the two additional experimental conditions were driving the effect. Considering the fact that the three-way interaction was not justified, and the fact that the effect was present in just these two additional blocks, we may rule out the possibility that the position of the unambiguous block affected ambiguity effects. On the other hand, the fact that polysemy advantage was detected in both orders of ambiguous blocks goes against the hypothesis that order plays a major role. Secondly, the lack of homonymy disadvantage was not a surprising pattern of results, considering the additional factors that are required in order to reliably capture it (Armstrong & Plaut, 2016; Eddington & Tokowicz, 2015; Hino et al., 2010; Rodd et al., 2002).

GENERAL DISCUSSION

The aim of this study was to attempt to put together, in a single experiment, the previously separately tested polysemy and homonymy effects in Serbian (Filipović Đurđević, 2019; Filipović Đurđević & Kostić, 2008; 2009 ;2017; 2021; Mišić & Filipović Đurđević, 2021). We tested whether the experimental context contributed to effect detection. This study was a conceptual replication with some methodological questions but, at its core, it was focused on the mental representations of ambiguous words. Even though we initially aimed to replicate the effects of separate experiments within a single study, this experiment revealed that there is more complexity to lexical ambiguity effects.

Surprisingly, both effects were absent in Experiment 1, so we conducted two more experiments, relying on the hypothesis that the presentation order and the switch from related to unrelated representations in the same task might affect processing. In those experiments, we controlled for the order of presentation by moving away from randomly mixed polysemous, homonymous, and unambiguous words, and towards each group of words being presented within a block (Experiments 2 and 3). Additionally, the order of the ambiguous word blocks was controlled (Experiments 2 and 3) and the effect of the position of the unambiguous block was monitored (Experiment 3). Experiment 2 revealed only a marginal polysemy advantage when the polysemous block was presented first, while Experiment 3 revealed a strong polysemy advantage in both ambiguous block orders. No homonymy effect whatsoever was detected in any of the three experiments.

Overall, the initial hypothesis that the experimental context affects ambiguity processing was confirmed, since polysemy advantage was detected in later experiments. This hypothesis came from different task effects that were detected throughout literature (Armstrong & Plaut, 2016; Eddington & Tokowicz, 2015; Hino et al., 2010; Rodd et al., 2002). The differences between the first experiment and the other two experiments further point towards the necessity of being aware of different task characteristics in order to reliably detect ambiguity effects.

Going into more detail regarding the particular aspects of the task, Experiment 2 suggests that controlling for the order of presentation may be the necessary condition for ambiguity effects detection, but Experiment 3 seems to disprove that suggestion. Detecting polysemy advantage in both orders rejected the idea that the order in which we encounter different ambiguity types during the experiment affects polysemy advantage. On the other hand, homonymy disadvantage was not detected in any of the experiments. As previously stated, this may not (only) be a consequence of the mixed random presentation of ambiguity types, but a general issue of homonymy disadvantage needing longer processing in order to emerge at all (Armstrong & Plaut, 2016).

Further evidence for experimental context playing an important role was provided by the fact that the stimuli were taken directly from two experiments in which the two ambiguity effects were demonstrated separately (Filipović Đurđević, 2019; Filipović Đurđević & Kostić, 2008; 2021; Mišić & Filipović Đurđević, 2021). Also, when different ways of describing ambiguity were used, such as number of meanings/senses, measures describing meaning/sense probability distributions, etc., the effects were present and reliable. This approach also gives better insight into ambiguity processing, considering the fact that matching groups by many variables when comparing ambiguity types as groups may lead to multiple statistical deficiencies (Baayen et al., 2008).

From a theoretical standpoint, these findings cannot be interpreted in a clear manner. None of the theories presented in the *Introduction* section make any claims regarding the influence of the mixed-presentation context, or the order of presentation of ambiguity types. However, the two classes of models could be distinguished based on the potential to account for the observed pattern of data. Our findings are not in line with the response system account (Hino et al., 2006, 2010) since these theories do not predict differences between polysemy and homonymy to begin with. Furthermore, they state that the amount of semantic information representing evidence for the correct response is not affected by sense/meaning relatedness. In our second experiment, we detected both polysemy advantage and homonymy disadvantage. Such effects would not be predicted by this account, considering that relatedness effects are neither predicted in a lexical decision task nor consistently observed in the experiments of that group of authors (Hino et al., 2006, 2010). Similarly, semantic competition models (Armstrong & Plaut, 2016; Rodd et al., 2004) do not predict the experimental context effects detected in our experiments. Firstly, the PDP models explain the opposite pattern of polysemy and homonymy effects by postulating cooperation and competition between representations within one ambiguous word. Experiments throughout literature observed regular polysemy and homonymy effects, regardless of both ambiguity types being present in the same experiment, or even randomly mixed (Armstrong & Plaut, 2016; Klepousniotou et al., 2008, 2012; Klepousniotou & Baum, 2007) Both groups of theories only describe processing and representing a single word. If any wider context is presented, it is always to probe a single sense/meaning, never to make any connections between different words. To the best of our knowledge, none of the current theories explain such findings, and no similar results have been reported. However, one of the semantic competition models, the SSD model (Armstrong & Plaut, 2016) allows the dynamics of the processes. For example, the processing of polysemous words is expected to be faster, and therefore presenting polysemous words in the first block could bring the system into the fast-processing zone without leaving

enough time for semantic competition (and cooperation) effects to emerge. Along the same line, presenting homonyms in the first block would bring the system into slower processing and give more time for semantic competition (and cooperation) effects to emerge. The results of our Experiment 2 are in line with this. However, Experiment 3 did not replicate the pattern. Having in mind the mixed results we obtained, we could suggest that even though the SSD model does not explicitly account for the experimental context effects, it may be a possible perspective for future research on this topic.

CONCLUSION

To conclude, our study found that polysemy advantage and homonym disadvantage are affected by the experimental context. Our attempt at controlling the order of the ambiguous word blocks did succeed in allowing polysemy advantage to emerge. Because it was detected in both orders of polysemy and homonymy blocks, we may conclude that this effect is affected by this order. The lack of homonymy disadvantage cannot be disentangled from the general difficulty of detecting this effect. None of the currently dominant theories such as the response-based account of Hino et al. (2006, 2010) or SSD model (Armstrong & Plaut, 2016), can account for our findings. The experimental context effects are more in line with the SSD model (semantic competition account) since it allows for dynamics during ambiguous words processing.

REFERENCES

- Allan, K. (Ed.). (2009). *Concise Encyclopedia of Semantics*. Oxford: Elsevier.
- Armstrong, B. C., & Plaut, D. C. (2016). Disparate semantic ambiguity effects from semantic processing dynamics rather than qualitative task differences. *Language, Cognition and Neuroscience, 31*(7), 940–966. <https://doi.org/10.1080/23273798.2016.1171366>
- Armstrong, B. C., Tokowicz, N., & Plaut, D. C. (2012). eDom: norming software and relative meaning frequencies for 544 English homonyms. *Behavior Research Methods, 44*(4), 1015–1027. <https://doi.org/10.3758/s13428-012-0199-8>
- Azuma, T., & Van Orden, G. C. (1997). Why SAFE Is Better Than FAST: The Relatedness of a Word's Meanings Affects Lexical Decision Times. *Journal of Memory and Language, 36*(4), 484–504. <https://doi.org/10.1006/jmla.1997.2502>
- Baayen, R. H., Davidson, D., & Bates, D. (2008). Mixed-effects modelling with crossed random effects for subjects and items. *Journal of Memory and Language, 59*(4), 390–412. <https://doi.org/10.1016/j.jml.2007.12.005>
- Baayen, R. H., & Milin, P. (2010). Analyzing Reaction Times. *International Journal of Psychological Research, 3*(2), 12–28. <https://doi.org/10.1287/mksc.12.4.395>
- Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language, 68*(3), 255–278. <https://doi.org/10.1016/j.jml.2012.11.001>

- Bates, D., Kliegl, R., Vasishth, S., & Baayen, R. H. (2015). *Parsimonious mixed models*. <https://arxiv.org/abs/1506.04967>
- Bates, D., Mächler, M., Bolker, B. M., & Walker, S. C. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67(1), 1–48. <https://doi.org/10.18637/jss.v067.i01>
- Cruse, A. (2000). *Meaning in language: An introduction to semantics and pragmatics*. Oxford University Press.
- Dragičević, R. (2010). *Leksikologija srpskog jezika* [Lexicology of the Serbian language]. Zavod za udžbenike.
- Eddington, C. M., & Tokowicz, N. (2015). How meaning similarity influences ambiguous word processing: the current state of the literature. *Psychonomic Bulletin & Review*, 22, 13–37. <https://doi.org/10.3758/s13423-014-0665-7>
- Filipović Đurđević, D. (2019). Balance of Meaning Probabilities in Processing of Serbian Homonymy. *Primenjena Psihologija*, 12(3), 283–304. <https://doi.org/10.19090/pp.2019.3.283-304>
- Filipović Đurđević, D., & Kostić, A. (2008). The effect of polysemy on processing of Serbian nouns. *Psihologija*, 41(1), 69–86. <https://doi.org/10.2298/PSI0801059F>
- Filipović Đurđević, D., & Kostić, A. (2017). Number, Relative Frequency, Entropy, Redundancy, Familiarity, and Concreteness of Word Senses: Ratings for 150 Serbian Polysemous Nouns. In S. Halupka-Rešetar & S. Martinez-Ferreiro (Eds.), *Studies in Language and Mind* (pp. 13–77). Faculty of Philosophy, University of Novi Sad. <http://digitalna.ff.uns.ac.rs/sadrzaj/2017/978-86-6065-446-7>
- Filipović Đurđević, D., & Kostić, A. (2021). We probably sense sense probabilities. *Language, Cognition and Neuroscience*. <https://doi.org/10.1080/23273798.2021.1909083>
- Gelman, A., & Hill, J. (2006). *Data Analysis Using Regression and Multilevel/Hierarchical Models*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511790942>
- Gortan-Premk, D. (1984). Polisemija i homonimija u srpskohrvatskom jeziku [Polysemy and homonymy in Serbo-croatian]. *Zbornik Matice Srpske za filologiju i lingvistiku* 27-28, 183–188.
- Gortan-Premk, D. (Ed.). (2003). *Semantičko-derivacioni rečnik*. Filozofski Fakultet, Odsek za Srpski Jezik i Lingvistiku.
- Gortan-Premk, D. (2004). *Polisemija i organizacija leksičkog sistema u srpskome jeziku*. [Polysemy and the organisation of the lexical system in Serbian language]. Zavod za udžbenike i nastavna sredstva.
- Gortan-Premk, D. (2018). Platisemija i similisemija u polisemantičkoj strukturi jedne lekseme. [Platysemy and simisemy in polysemantic structure of a lexeme] *Naš jezik*, 49(1), 1–12
- Grickat, I. (1967). Stilske figure u svetlu jezičkih analiza. [Figures of speech in the light of linguistic analyses] *Naš jezik*, 16(4) 217-235.
- Hino, Y., Kusunose, Y., & Lupker, S. J. (2010). The relatedness-of-meaning effect for ambiguous words in lexical-decision tasks: when does relatedness matter? *Canadian Journal of Experimental Psychology = Revue Canadienne de Psychologie Expérimentale*, 64(3), 180–196. <https://doi.org/10.1037/a0020475>
- Hino, Y., Lupker, S. J., & Pexman, P. M. (2002). Ambiguity and Synonymy Effects in Lexical Decision, Naming, and Semantic Categorization Tasks: Interactions between Orthography, Phonology, and Semantics. *Journal of Experimental Psychology: Learning Memory and Cognition*, 28(4), 686–713. <https://doi.org/10.1037/0278-7393.28.4.686>
- Hino, Y., Pexman, P. M., & Lupker, S. J. (2006). Ambiguity and relatedness effects in semantic tasks: Are they due to semantic coding? *Journal of Memory and Language*, 55(2), 247–273. <https://doi.org/10.1016/j.jml.2006.04.001>

- Klepousniotou, E. (2002). The Processing of Lexical Ambiguity: Homonymy and Polysemy in the Mental Lexicon. *Brain and Language*, 81(1–3), 205–223. <https://doi.org/10.1006/brln.2001.2518>
- Klepousniotou, E., & Baum, S. R. (2007). Disambiguating the ambiguity advantage effect in word recognition: An advantage for polysemous but not homonymous words. *Journal of Neurolinguistics*, 20(1), 1–24. <https://doi.org/10.1016/j.jneuroling.2006.02.001>
- Klepousniotou, E., Titone, D., & Romero, C. (2008). Making Sense of Word Senses: The Comprehension of Polysemy Depends on Sense Overlap. *Journal of Experimental Psychology: Learning Memory and Cognition*, 34(6), 1534–1543. <https://doi.org/10.1037/a0013012>
- Kostić, Đ. (1999). *Frekvencijski rečnik savremenog srpskog jezika [Frequency dictionary of the contemporary Serbian language]*. Institut za eksperimentalnu fonetiku i patologiju govora i Laboratorija za eksperimentalnu psihologiju.
- Lopukhina, A., Laurinavichyute, A., Lopukhin, K., & Dragoy, O. (2018). The mental representation of polysemy across word classes. *Frontiers in Psychology*, 9, 192. <https://doi.org/10.3389/fpsyg.2018.00192>
- Lyons, J. (1977). *Semantics, volume 2*. Cambridge University Press. <https://doi.org/10.1017/CBO9781139165693>
- Mathôt, S., Schreij, D., & Theeuwes, J. (2012). OpenSesame: An open-source, graphical experiment builder for the social sciences. *Behavior Research Methods*, 44(2), 314–324. <https://doi.org/10.3758/s13428-011-0168-7>
- Matuschek, H., Kliegl, R., Vasishth, S., Baayen, R. H., & Bates, D. (2017). Balancing Type I error and power in linear mixed models. *Journal of Memory and Language*, 94, 305–315. <https://doi.org/10.1016/j.jml.2017.01.001>
- Mišić, K. & Filipović Đurđević, D. (2019). Testing semantic settling dynamics model predictions – homonym meaning uncertainty. *Current Trends in Psychology Book of Abstracts, Faculty of Philosophy, Novi Sad, October 24–27, 2019, Book of Abstracts*, 119–120.
- Mišić, K., & Filipović Đurđević, D. (2021). Redesigning the exploration of semantic dynamics: SSD account in light of regression design. *Quarterly Journal of Experimental Psychology*. <https://doi.org/10.1177/17470218211048386>
- R Core Team. (2018). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://www.r-project.org/>
- Rodd, J. M. (2020). Settling Into Semantic Space: An Ambiguity-Focused Account of Word-Meaning Access. *Perspectives on Psychological Science*, 15(2), 411–427. <https://doi.org/10.1177/1745691619885860>
- Rodd, J. M., Gaskell, G., & Marslen-Wilson, W. (2002). Making Sense of Semantic Ambiguity: Semantic Competition in Lexical Access. *Journal of Memory and Language*, 46(2), 245–266. <https://doi.org/10.1006/jmla.2001.2810>
- Rodd, J. M., Gaskell, G., & Marslen-Wilson, W. (2004). Modelling the effects of semantic ambiguity in word recognition. *Cognitive Science*, 28(1), 89–104. <https://doi.org/10.1016/j.cogsci.2003.08.002>
- RMS – Rečnik Matice Srpske. (1967 – 1976). *Rečnik srpskohrvatskoga književnog jezika, t. I-VI [Dictionary of Serbo-Croatian literary language]*. Matica Srpska.
- Schad, D. J., Vasishth, S., Hohenstein, S., & Kliegl, R. (2020). How to capitalize on a priori contrasts in linear (mixed) models: A tutorial. *Journal of Memory and Language*, 110, 104038. <https://doi.org/10.1016/j.jml.2019.104038>
- Tafra, B. (1986). Razgraničavanje homonimije i polisemije (leksikološki i leksikografski problem) [Distinguishing between homonymy and polysemy (lexicological and lexicographic problem)]. *Filologija*, 14, 381–393.
- Wickham, H. (2016). *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. <https://ggplot2.tidyverse.org>

УТИЦАЈ ЕКСПЕРИМЕНТАЛНОГ КОНТЕКСТА НА ЕФЕКТЕ ВИШЕЗНАЧНОСТИ РЕЧИ

Ксенија Мишић¹, Душица Филиповић Ђурђевић²

¹Универзитет у Београду, Филозофски факултет,

Лабораторија за експерименталну психологију, Београд, Србија

²Универзитет у Београду, Филозофски факултет, Департман за психологију,

Лабораторија за експерименталну психологију, Београд, Србија

Резиме

Претходна истраживања су показала да се различити типови вишезначних речи обрађују на различите начине у задатку лексичке одлуке. Полисемичне речи (више повезаних значења) се обрађују брже од једнозначних речи, док се хомоними (више неповезаних значења) обрађују спорије од једнозначних речи. Овај склоп резултата реплициран је и у српском језику, мада у одвојеним студијама. Циљ овог рада био је да се испита да ли се ови ефекти могу поновити када се обе врсте вишезначности налазе унутар исте експерименталне листе.

Први експеримент није показао разлику у обради ниједног типа вишезначности у односу на једнозначне речи. Овај налаз је у складу са великим делом литературе, у којој је пронађено да се у различитим експерименталним задацима бележе различити резултати. На основу овога, закључено је да сам експериментални контекст (мешана презентација различитих типова вишезначности), може утицати на резултате.

Друга два експеримента настојала су да контролишу управо сам експериментални контекст. Све три групе речи приказане у првом експерименту (полисемичне речи, хомоними и једнозначне речи) приказане су унутар истог блока, док је редослед блокова био контрабалансиран. Циљ овога је био да се испита да ли контролисање редоследа излагања може да помогне у бележењу ефеката вишезначности. У другом експерименту забележен је маргинални ефекат полисемије, док је у трећем забележен ефекат полисемије у оба редоследа блокова са вишезначним речима.

Имајући у виду да се у литератури типично најчешће бележи ефекат полисемије, док су за јављање ефекта хомонимије потребни додатни услови, резултати забележени у три изложена експеримента показују да контекст утиче на јављање ефеката полисемије. Иако контрола редоследа излагања омогућава јављање ефекта полисемије, није довела и до јављања ефекта хомонимије. Овакав склоп резултата указује на то да су за потпуну репликацију експеримената у којима су оба ефекта забележена истовремено, потребни другачији експериментални услови.