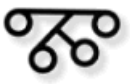
SVEUČILIŠTE U ZAGREBU
FILOZOFSKI FAKULTET
ODSJEK ZA ANGLISTIKU

DIPLOMSKI STUDIJ ANGLISTIKE
SMJER: LINGVISTIČKI

Toni Perko

Mental models and memory in reading

Diplomski rad



Mentor:
dr. sc. Irena Zovko Dinković, izv. prof.

2016.

1. Introduction

A mental model is an explanation of someone's thought process on the way that the world works. A person with a specific mental model, as each person can have their own specific mental model, can have an understanding of the world around them that is different from the next person. The focus of this paper is primarily to determine the relationship of externally constructed mental models on a person's working memory when reading and recalling a text in a controlled environment. The secondary purpose of the paper will test the differences in verbal working memory capacity between monolingual and bilingual students as it is argued that a higher level of verbal working memory can be indicative of a second language proficiency (Namazi 2010).

The paper will present the results of a research that was based upon Anderson and Pichert's (1979) paper, which also had a goal of analyzing how a person's recall of a text would be dependent on a constructed schema within the text.

Upon explaining the procedure of the research in detail, the gathered results will be analyzed and compared across different groups of participants in order to determine the validity of the primary hypothesis that constructing a mental model will affect the readers' recall of terms from the text when looking at the semantic domain that they belong to.

Additionally, we will set a second hypothesis which states that bilinguals will have a higher capacity of working memory when compared to their monolingual peers. The data gathered from the research will be analyzed further to determine the validity of the hypothesis.

2. Mental models

Mental models, which can also be called situation models, are a mental representation of a person's understanding of a real or imaginary world (Radvansky, 2000). Each person constructs a mental model for a situation that they are currently experiencing or have experienced before and that is what helps them comprehend the world around them. The process of constructing a mental model heavily depends on a person's experience with a certain subject.

Since the main purpose of this paper is to determine how a constructed mental model can affect the reader's recall of a text, we will focus on the effects of mental models on comprehension. The main goal of comprehension is to construct a mental model. The process of constructing a mental model consists of three types of mental representations, the first one being the verbatim[1] representation of what was seen or heard. This representation will be quickly forgotten unless there is something extremely important about the exact way that something happened. In this representation, a person recalls the specifics of an event or text. The second, more abstract, is the propositional textbase. In this representation, a person will remember the idea of an event, rather than the exact order or wording. Sentences "Mark hit the ball" and "The ball was hit by Mark" will represent the same idea and this will be less easily forgotten. The final level of constructing a mental model is the mental model itself. In this level the person constructs what the whole message is about and it will be the least likely to be forgotten.

The effect of mental models and mental schemata can be seen in memory retrieval (Heeter 1997). The details of a situation that are more important are less likely to be forgotten than the details that are less important. As a person constructs a mental model, he/she will determine what is more and less important based on past experience, but also on the information that is externally provided. The effect of externally provided information will be important for us as it is the primary focus of the paper.

Further on the paper will focus on the effect that bilingualism has on the capacity of working memory in students and it is expected that bilingual students will exhibit a higher capacity of working memory than bilingual students.

[1] Corresponding word for word to the original source or text

3. Memory in bilinguals

The effects of bilingualism on a person's memory have been a subject of extensive research. It is argued that bilingualism has an effect on the speaker's working memory capacity as a bilingual has a need for storing a vast amount of new words when acquiring a new language. It is also argued that a person who has a generally higher capacity of working memory is more likely to be able to learn a second language more proficiently. (Szmalec, 2012)

Miller (1956) defined the capacity of working memory to be seven items plus or minus two. More recent studies suggest that the capacity of working memory is four items (Garavan, 1998; Oberauer, 2002). However, of these four, only one can be the main focus at a time.

While these studies put limits on the capacity of working memory, research has shown that proficient bilinguals show a higher capacity of working memory than monolinguals. Within his study, Adesope (2010) conducted an analysis of several cognitive components, along with working memory. The analysis showed that bilinguals have an overall advantage in working memory capacity over their monolingual peers in a moderate effect. Since students of English had received formal linguistic education and they were highly proficient in English, they were, for the purpose of this paper, considered to be sequential bilinguals.

The purpose of this paper and the research conducted for it will be to determine if the difference in the working memory capacity is visible between monolingual students speaking Croatian and bilingual students speaking Croatian and English. The research is designed to test both the capacity of working memory when reading texts in a student's mother tongue and the second language which they are fluent in.

The research also takes into account the number of languages the students speak and attempts to find a connection between working memory capacity and the number of languages spoken.

4. Research

The main hypothesis of the research is that students who have some form of formal linguistic education will exhibit a higher capacity of working memory when reading and recalling a text than students who do not have any kind of formal linguistic education. Formal linguistic education is considered, in this case, to be the fact that participants have been studying a foreign language at a university level for at least two years. The secondary aim of this research is to observe whether higher working memory capacity will be exhibited in both languages when reading a text in case of bilingual students who have formal linguistic education.

Another point of observation in the research will be whether constructing a mental model for the participants, at the beginning of the text that they will read, will make them more inclined to memorize the terms that are related to that constructed mental model. The results that we anticipated were that constructing a mental model will make the students slightly more inclined to memorize more terms relating to the constructed mental model.

We expected that students who have formal linguistic education will have a slightly higher capacity of working memory when recalling a text due to their need to be able to memorize a greater number of new words and concepts during their studies. Only a slightly higher capacity of working memory is expected due to the previous research on working memory capacity done by Garavan (1998) and Oberauer (2002), which showed that the capacity of working memory is around four items per person, whereas research done by Miller (1956) concluded that this capacity is seven items plus or minus two.

4.1. Participants

The research was conducted on 54 participants, all of whom are students at the Faculty of Humanities and Social Sciences in Zagreb. The participants were divided into three primary groups, based on their formal linguistic education. Two groups of participants have formal linguistic education, while one group does not. The groups were labeled as Group 1 (no formal linguistic education), Group 2 (formal linguistic education) and Group 3 (formal linguistic education). It is important to note that all of the participants in Group 1 had a bachelor's degree while all of the participants in Groups 2 and 3 had been pursuing their bachelor's degree and had finished high school at the time when the research was being conducted.

The average age of the participants in all three groups was 21.87 years of age and of the 54 participants, 13 of them (24%) were male while 41 (76%) were female.

The number of languages learned across all three groups was on average 3.14 per participant.

All of the student's mother tongue was Croatian and all of them learned English as a second language for the longest period, ranging from eight to nineteen years.

The participants were further divided into six additional groups, two per primary group, where one half was given a text beginning with "Imagine you are a burglar" and the other half was given a text begging with "Imagine you are buying a house". The participants were divided into these secondary groups randomly.

4.2. Materials

The materials used in the research for this paper consisted of a questionnaire and a text that the participants were required to read. The questionnaire was printed on single sheet of paper on one side while the text was printed on a single sheet of paper on both sides. One side contained the text that the participants were required to read, while the other side contained a place for the participants to write down what they remembered after reading the text.

The questionnaire was composed in a way to keep the test anonymous and its purpose was to find out the level of education, age, number of languages learned and whether the participants had any formal linguistic education. If the students had formal linguistic education (i.e. They were students at the department of English) they were considered to be sequential bilinguals as they are highly proficient in English.

The purpose of the questionnaire is to determine the linguistic education of the participants as it is going to be argued that participants who have formal linguistic education have a higher capacity of working memory than the students who haven't received any kind of formal linguistic education.

Upon completing the questionnaire, the participants received a text for which they had 15 seconds to read. The text that was used for the research is taken from Anderson and Pichert (1978). It is important to note that, since the text is from 1978, it is possible that the participants were confused by the wording and the items that appeared in the text. Both the questionnaire and the text were prepared in Croatian and English. The English text consisted of six sentences containing 97 words. It was printed on a single sheet of paper and the text was located

approximately in the middle of the paper, while at the top of the paper the participants were given two sentences with instructions.

The Croatian translation of the text consisted of six sentences containing 108 words and was also printed on a single sheet of paper. The locations of the parts of the text were the same as in the English version.

The text was prepared in four different versions - two in Croatian and two in English. The only difference between the two version of the text is the first sentence of the instructions where one half of the group was given a text beginning with "Imagine you are a burglar", while the other half received the text beginning with "Imagine you are buying a house".

Both texts contain 15 pieces of information that could be easily remembered. Six of them are more semantically related to the burglar's point (e.g. the boys mother is not home on Thursdays, the family owns a valuable coin collection etc.) of view and six are more semantically related to the point of view of a person buying a house (e.g. the roof of the house is leaking, the cellar is damp and moldy etc.). Three pieces were deemed neutral and not related to any of the two points of view (e.g. the boys are playing hooky).

All of the materials that were used in this research can be found at the end of this paper and are given in Appendix 1.

4.3. Procedure

The research consisted of two parts. For the first part of the research, participants were given the questionnaire and were asked to fill it out. Participants received no further information about the purpose of the research, apart from the information that the research was being done as part of a master's thesis at the Department of English at the Faculty of Humanities and Social Sciences in Zagreb. The participants were all informed that the research was anonymous and all were given the option not to participate. They were given no additional information on the research in order not to influence the results and were only told what the aim was upon completing the task.

Group 1 consisted of students who had been studying Information sciences and were all given the questionnaire and the text in Croatian. Group 2 and Group 3 consisted of students of English, where Group 2 was given the questionnaire and the text in their mother tongue

(Croatian), and Group 3 was the only group that received the questionnaire and the text in English.

The research was first conducted on Group 1 in one of the classes that all of the participants were attending. The research on groups 2 and 3 was also conducted in common college level classes that all participants were attending. Groups 2 and 3 were not aware that the language in which they received the questionnaire and the text were different.

After explaining the task to the participants, the questionnaire was handed out and ample time was provided for them to fill in all the necessary information. Once the participants had completed the questionnaire, all of them received the paper with the text and the part where they had to write down everything that they remembered from the text. The text was facing down and the participants were asked not to turn the paper until instructed.

After being instructed to turn the paper, the participants had 15 seconds to read the text and then they were required to turn the paper over and write down everything that they remembered from the text in either bullet points or full sentences.

4.4. Results

The results of the research will be presented for each group separately, and then viewed together and discussed with the attempt to determine whether the initial hypothesis was true.

The results of the research will focus on a number of terms the participants recalled from the text while special attention given to the number of terms remembered from each of the two separate semantically related groups.

4.4.1. Group 1

Group 1 consisted of 18 students who never received any form of formal linguistic education. The average age of all participants was 25 years of age and the group consisted of the of 8 male and 10 female participants. The number of languages learned by a participant in this group is an average of 2.33 per participant. Participants were divided into two secondary groups of nine students each. All participants received the questionnaire and the text in Croatian, but 9

received the text starting with “Zamislite da te provalnik” (Imagine you are a burglar) and 9 received the text starting with “Zamislite da kupujete kuću” (Imagine you are buying a house).

The data gathered from Group 1 show that, on average, a participant from this group recalled 5.5 terms after having 15 seconds to read the text.

When looking at the data and the semantic domain that the terms belong to, all of the participants recalled on average 2.66 terms that are related to the mental model of being a burglar and an average of 1.77 terms relating to the mental model of buying a house.

When looking at the group of nine participants that were given the text with beginning with the sentence “Imagine you are buying a house”, the participants recalled an average of 2.77 terms related to the terms from the domain of burglary and 2.11 terms related to the domain of buying a house.

The group of participants that were given the text beginning with the sentence “Imagine you are a burglar” recalled on average 2.55 terms relating to the semantic group of terms related to the domain of burglary and 1.44 terms related to the sematic domain of buying a house.

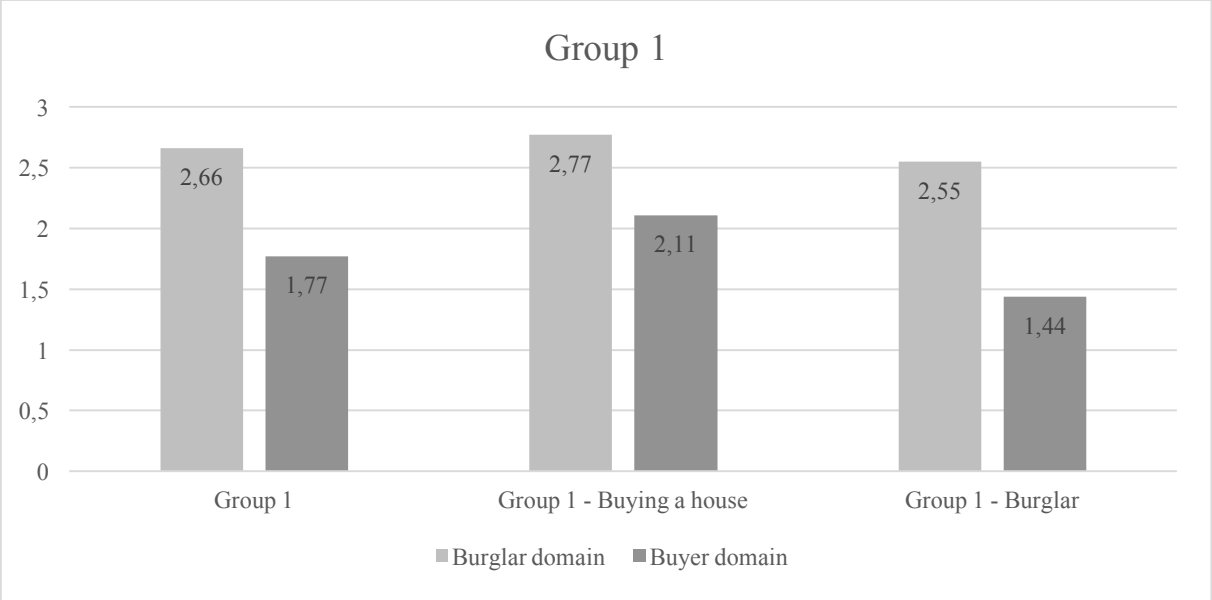


Table 1

4.4.2. Group 2

Group 2 consisted of 18 students who received formal linguistic education as all of the participants were students of the English language and literature. The average age of all

participants was 20 years and the group consisted of 2 male and 16 female participants. The number of languages learned was an average of 3.61 per participant. Participants were divided into two secondary groups of nine students each. All participants received the questionnaire and the text in Croatian, their mother tongue, but 9 received the text starting with “Zamislite da ste provalnik” (Imagine you are a burglar) and 9 received the text starting with “Zamislite da kupujete kuću” (Imagine you are buying a house).

The data gathered from Group 2 showed that, on average, a participant from this group recalled 5.33 terms after having 15 seconds to read the text.

When looking at the data and the semantic domain that the terms belong to, all of the participants recalled on average 2.1 terms that were related to the mental model of being a burglar, and average 2 terms relating to the mental model of buying a house.

When looking at the group of nine participants that were given the text with the sentence “Imagine you are buying a house”, the participants recalled an average of 1.77 terms related to the semantic domain of burglary and 1.88 terms related to the sematic domain of buying a house.

The group of participants that were given the text beginning with the sentence “Imagine you are a burglar” recalled on average 2.44 terms relating to the semantic domain of burglary and 2.11 terms related to the sematic domain of buying a house.

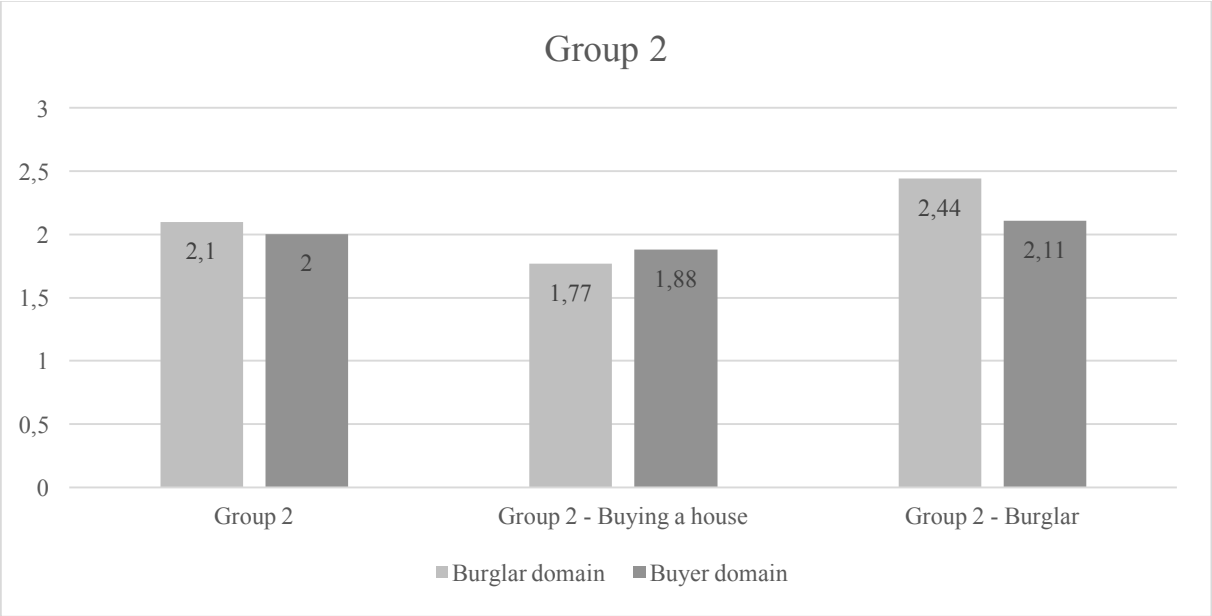


Table 2

4.4.3. Group 3

Group 3 of consisted of 18 students who had formal linguistic education and all of the participants were students of the English language and literature. The average age of all participants was 20 years and the group consisted of 3 male and 15 female participants. The number of languages learned by a participant in this group is an average of 3.5 per participant. Participants were divided into two secondary groups of nine students each. All participants received the questionnaire and text in English, but 9 received the text starting with "Imagine you are a burglar" and 9 received the text starting with "Imagine you are buying a house".

The data gathered from Group 3 shows that, on average, a participant from this group recalled 4.61 terms after having 15 seconds to read the text.

When looking at the data and the semantic domain that the terms belong to, all of the participants recalled on average 1.94 terms that were related to the mental model of being a burglar, and on average 1.5 terms relating to the mental model of buying a house.

When looking at the group of nine participants that were given the text with the sentence "Imagine you are buying a house", the participants recalled an average of 1.55 terms related to the semantic domain of burglary and 1.33 terms related to the sematic domain of buying a house.

The group of participants that were given the text beginning with the sentence "Imagine you are a burglar" recalled on average 2.33 terms relating to the semantic domain of burglary and 1.66 terms related to the sematic domain of buying a house.

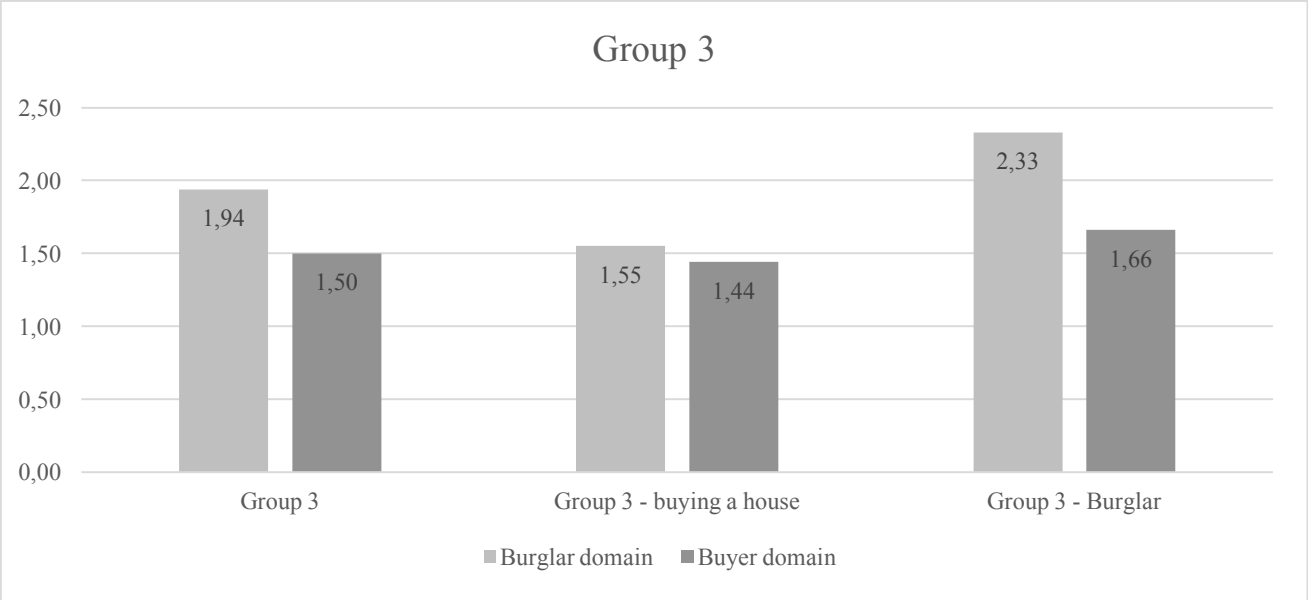


Table 3

5. Discussion

The results that were obtained in this research across all of the three groups of participants show that even though Group 1, which received no formal linguistic education and had on average learned 2.33 foreign languages per participant, had a greater number of recalled terms. Looking at the results of the research, we can see that Group 1 recalled an overage of 5.5 terms per participant, while Group 2 recalled an average of 5.33 terms per participant. Group 3 recalled an average of 4.61 terms per participant. These numbers suggest that formal linguistic education had no role in the capacity of the student's working memory, but rather that the language that the students received the text in played a more important role. This can be seen when comparing the results of Group 2 and Group 3, whose participants received formal linguistic education. Group 3, which received the text in English, recalled a lower number of terms than Group 2, which received the text in Croatian, the participants' mother tongue. It was expected that the number of terms recalled in Group 2 and 3 would be greater than the number of terms recalled in Group 1 as the students in the former groups were considered to be bilingual due to the fact that they had been receiving formal linguistic education.

Looking at the number of terms recalled when viewing the semantically related terms, we can see that the terms relating to the semantic domain of being a burglar had a greater number of recalled terms in all three groups. This difference is most obvious in Group 1 where participants recalled on average almost one full term more relating to the domain of the burglar than the

domain of a person buying a house. The difference is less noticeable in Group 3 where there is 0.5 terms in favor of the terms relating to the burglar domain and the difference is the least obvious in Group 2 where it is only 0.1 terms on average and it is insignificant.

Since the main focus of the paper is to determine the effect of constructed mental models on the working memory of readers, the results may be considered relevant because they show that, when the participants were recalling the terms from the text that they have read and they were operating under a constructed mental model of being a burglar, they recalled a significantly greater number of terms relating to the semantic domain of the burglar. This difference in the number of terms could be related to the concept of priming.[2] This difference is most visible in Group 1 where it was an average of 1.11 terms more than the number of terms recalled relating to the semantic domain of buying a house. The difference is less present in Group 3, where people recalled 0.66 terms more, and in Group 2, where they recalled 0.33 terms more. But these results show that constructing a mental model affects a person's memory and that the person will pay more attention to the terms that he/she finds more important.

When looking at the results of the groups of participants who were operating under the constructed mental model of buying a house, the results are more complex. Only Group 2 showed a greater number of recalled terms which are related to the semantic domain of buying a house and the difference was only 0.11 terms on average. Groups 1 and 3 still recalled a greater number of terms that are related to the semantic domain of burglary, but in this case, the difference was smaller: in Group 1, it was 0.66 terms on average, and in Group 3, it was only 0.11 terms on average in favor of the terms related to the semantic domain of the burglar. When comparing this data to the data of the participants who were operating under the constructed mental model of being a burglar, we can see the number of terms recalled relating to the semantic domain of the burglar dropped and that the number of terms recalled relating to the semantic domain of buying a house slightly increased. Although it was expected that the number of terms recalled relating to the semantic domain of buying a house would be substantially bigger, as was the case with participants operating under the constructed mental

[2] Priming is the implicit memory effect in which exposure to one stimulus influences a response to another stimulus. Conceptual priming in linguistics can cause a person to recall terms similar to the original stimulus better that the terms that are not similar. (Schvaneveldt and Meyer, 1973)

model of being a burglar, these results still show an effect of the mental model on the memory of the reader.

The results of the research show that having formal linguistic education does not necessarily invoke a higher capacity of working memory in the reader even if they are dealing with a specifically linguistic task, since Group 1, which was comprised of participants who had no formal linguistic education, performed best when it came to recalling the terms from the text. The group which performed least successfully was Group 3, whose participants were the only group not doing the task in their mother tongue. While the difference in the number of terms recalled between Groups 1 and 2 is less significant, it is still present and needs to be taken into account. The results are slightly unexpected as Adesope's (2010) study suggested that bilinguals should exhibit a higher capacity of working memory than monolinguals. What needs to be taken into account is the fact that it was the monolingual group that performed most successfully, and the bilingual group that read and recalled the text in English the one that performed the least successfully, which could suggest that the participants were not fully proficient in their second language.

The results relating to the effect of a constructed mental model on the recall of participants show that constructing a mental model for the reader will have an effect on the semantic domain of terms that the reader is more likely to recall from a text. While the expected results were not present in the groups of participants who were operating under the constructed mental model of buying a house, the results that were achieved still show that participants in these groups recalled a greater number of terms relating to the sematic domain of the buyer and a lower-than-average number of terms relating to the sematic domain of being a burglar.

6. Conclusion

The purpose of this paper and the research that was carried out for it was to determine whether constructing a mental model for the reader would have an effect on the terms that would be recalled by the reader after having a short time to read through a text. Research that was conducted by Heeter (1997) showed that constructing a mental model would have an effect on the reader's memory retrieval and the results that were gathered in the research for this paper have confirmed this. While the results were not as obvious as expected, it can be seen that constructing a mental model within the text for the reader will have an impact on the terms that will be recalled. These results have confirmed the primary hypothesis of the paper.

The secondary hypothesis of the paper which claimed that the capacity of the working memory would be higher in bilingual students when compared to their monolingual colleagues has not been confirmed since monolingual participants have shown a higher capacity of working memory when recalling the text that they read. Although previous research showed a higher capacity of working memory in bilinguals than in monolinguals, the results of this research have not confirmed this even when comparing only the groups of participants who participated in the research in their mother tongue.

In conclusion, mental models can affect the semantic memory of the reader. Constructing a mental model for the reader will make him more likely to remember parts of the text that he/she finds more important. Additionally, bilingualism appears to have no effect on the capacity of the working memory in students of a foreign language although previous research suggested otherwise.

Bibliography

Adesope, Olsula et al. “A systematic review and meta-analysis of the cognitive correlates of bilingualism.” *Review of Educational Research*, 80 (2), 2010:207 – 245. Web.
Anderson, R, Pichert, James et al. Effects of a reader’s schema at different points in time. University of Illinois. 1979.

Garavan, Hugh. “Serial attention within working memory.” *Memory and Cognition*. 26, 1998:263–276.

Heeter, Carrie, Rampoldi Hnilo, Lynn, Winn, Brian M. Recall and Mental Models: Designing A User Interface To Affect Memory. 1997.

Miller, George. “The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information.” *Psychological Review* 63. 1965.
Namazi, Mahchid, Thordardottir, Elin. “A working memory, not bilingual advantage, in controlled attention.” *International Journal of Bilingual Education and Bilingualism. 13*(5), 2010:597-616.

Oberauer, Klaus. “Access to information in working memory: Exploring the focus of attention.” *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 28(3), 2002:411-421.

Radvansky, Gabriel and Copeland, David. “Functionality and Spatial Relations in Situation Models” *Memory and Cognition* 28:987–992. 2000.

Schvaneveldt, R.W.; Meyer, D.E. (1973), "Retrieval and comparison processes in semantic memory." Kornblum, S., *Attention and performance IV*, New York: Academic Press, pp. 395–409

Szmalec, Arnaud, Brysbaert, Marc and Duyck, Wouter. “Working memory and second language processing.” *Memory, Language, and Bilingualism*. Cambridge University press. 2012.

Appendix 1

Questionnaires and texts used during the research

Spol - M / Ž

Dob - _____

Stručna sprema: _____

Koje ste strane jezike učili i koliko dugo?

_____

_____

_____

_____

_____

Imate li ikakvo formalno lingvističko obrazovanje? DA / NE

Sex - M / F

Age - _____

Level of education: _____

Which languages did you learn and for how long?

_____

_____

_____

_____

_____

Do you have any kind of formal linguistic education? YES / NO

Zamislite da kupujete kuću. Imate 15 sekundi da pročitate ovaj tekst.

Dvojica dječaka markiraju iz škole. Odlaze u dom jednog od dječaka jer njegova majka nikada nije tamo četvrtkom. Njegova obitelj je dobrostojeća. Imaju lijep i star dom koji je smješten podalje od ceste i koji ima prostrano i lijepo dvorište. No budući da je kuća stara, ima nekoliko nedostataka; na primjer, krov prokišnjava, a podrum je vlažan i pun plijesni. Budući da je obitelj imućna, imaju mnoštvo vrijednih stvari kao što su bicikl s deset brzina, televizor u boji i zbirka rijetkih novčića.

Imagine you are buying a house. You have 15 seconds to read this text.

Two boys play hooky from school. They go to the home of one of the boys because his mother is never there on a Thursday. The family is well off. They have a fine old home which is set back from the road and which has attractive grounds. But since it is an old house, it has some defects; for example, it has a leaky roof and a damp and musty cellar. Because the family is wealthy, they have a lot of valuable possessions such as a ten-speed bike, a color television and a rare coin collection.