Mental models and inference in reading comprehension

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Mental models and inference in reading comprehension

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Abstract

Reading is a complex cognitive process, which involves decoding symbols and recognizing words, leading to the development of comprehension. According to Schema Theory, comprehending a text is an interactive process between the reader's background knowledge and the text. WM, which has a limited capacity store for briefly retaining information while performing mental operations, is extremely important in the process of reading and recalling. The construction of a coherent mental model is the goal of comprehension but it is limited by WM capacity. Constructing a mental model using previously learned or schematic knowledge requires the reader to make inferences about situations in the text. This thesis deals with the impact of mental models on readers' recall of a text and its focus is primarily to prove that all readers make a number of incorrect inferences besides the correct ones, when reading and recalling the text. The second purpose of the thesis is to examine the differences in Working Memory capacity between three groups of participants – native speakers of English, native speakers of Croatian without a degree in English, and native speakers of Croatian who either have a degree in English or are students of English. The research was conducted online and it involved a total of 120 participants. The results show that all readers make incorrect inferences beside the correct ones when reading and recalling a text. Furthermore, they reveal that bilinguals do not have any advantages or disadvantages, i.e. higher or lower WM capacity when compared to monolinguals.

Keywords: **mental models**, **inference**, **reading comprehension**, **working memory**

Sažetak

Čitanje je složen kognitivni proces, koji uključuje "dešifriranje" znakova i prepoznavanje riječi, što dovodi do razumijevanja. Prema teoriji shema, razumijevanje teksta interaktivni je proces između čitateljevog pozadinskog znanja i teksta. Radna memorija, koja je spremište ograničenog kapaciteta za kratko zadržavanje informacija tijekom obavljanja mentalnih operacija, izuzetno je važna pri čitanju i prisjećanju teksta. Konstrukcija skladnog mentalnog modela cilj je razumijevanja, no ograničena je kapacitetom radne memorije. Konstruiranje mentalnog modela korištenjem prethodnog znanja ili shema zahtijeva od čitatelja donošenje zaključaka o situacijama u tekstu. Ovaj se diplomski rad bavi utjecajem mentalnih modela na čitateljevo prisjećanje teksta. Njegov osnovni cilj je dokazati da svi čitatelji donose čitav niz

pogrešnih zaključaka (inferencija) tijekom čitanja i prisjećanja teksta. Druga svrha rada je ispitivanje razlika u radnoj memoriji između tri skupine ispitanika: izvornih govornika engleskog, izvornih govornika hrvatskog koji nisu diplomirani anglisti te izvornih govornika hrvatskog koji su diplomirani anglisti ili studenti engleskoga jezika. Istraživanje je provedeno putem interneta, a sudjelovalo je 120 ispitanika. Rezultati pokazuju da svi čitatelji prilikom čitanja i prisjećanja teksta uz ispravne zaključke donose i one pogrešne. Nadalje, rezultati otkrivaju da dvojezičari nemaju nikakve prednosti ili manjak prednosti, tj. veći ili manji kapacitet radne memorije u odnosu na jednojezičare.

Ključne riječi: **mentalni modeli**, **inferencije**, **razumijevanje teksta**, **radna memorija**

1. Introduction

Mental models are mental representations that are close to the structure of the world rather than to the structure of the language that describes the world (Johnson-Laird, 1983). To put it simply, a mental model is an explanation of someone's thought process about how something works in the real world. Some mental models seem innate among humans, while others are acquired through experience particular to the individual. Many mental models come from experiences that are particular to an environment, which means that they are widely shared within one society but not in other societies (World Bank, 2015:63). According to Radvansky and Copeland (education.stateuniversity.com), the creation of a coherent mental model is the goal of comprehension – a text is understood if the language users are able to construct a mental model for it. Readers construct mental models by combining meaning elements of the text, information from previous old models and specific instances of generally socially shared knowledge (Hart and Lukeš, 2009:87). The construction of mental models for narrative texts also requires that the reader adopts a strategy for deciding what information to keep active in memory.

An inference is defined as "the information that is not expressed explicitly by the text but is derived on the basis of the understander's knowledge and is encoded in the mental representation of the text" (Noordman and Vonk, 2015:37). Correct/incorrect inferences derive from mental models constructed by the reader.

This paper deals with the impact of mental models on reader's recall of a text and its focus is primarily to prove that all readers make a number of incorrect inferences besides the correct ones, when reading and recalling a text.

The second purpose of the paper is to examine the differences in Working Memory capacity between 3 groups of participants - native speakers of English, native speakers of Croatian without a degree in the English language, and native speakers of Croatian who either have a degree in English or are students of English, since it is believed that bilinguals' dual language processing imposes a heavier cognitive load on their Working Memory (Yang, 2017:1).

After a thorough presentation of the research procedure, the obtained results are analyzed and compared across different groups of participants in order to determine the validity of the

primary hypothesis that all readers make a number of incorrect inferences besides the correct ones, when reading and recalling a text.

Chapter 2 explains the stages of the reading process and explains the role of reader's schema in reading comprehension. Chapter 3 discusses memory, with particular attention on Working Memory. Chapter 4 deals with mental models, inference and spatial representation. Chapters 5 and 6 analyze and discuss the results of the research. Chapter 7 offers some conclusions based on the theoretical and empirical work presented here.

2. Reading process

Reading is a complex cognitive process, which involves decoding symbols and recognizing words, leading to the development of comprehension. It can also be described as a process that negotiates the meaning between the text and its reader. According to Kusiak-Pisowacka (2016:26), reading research is a little more than one hundred years old. Over that time it has shifted from studies of remembering lists of words to comprehension of sentences and finally to the mental processes of comprehending coherent texts. *Reading comprehension* is "an intentional, active, interactive process that occurs before, during and after a person reads a particular piece of writing" (Mahapatra and Sabat, 2016:16). It operates on two different semantic levels: the micro level, which refers to the local discourse of the text, and the macro level, referring to the more global discourse of the text.

In the past, reading was considered a 'passive skill' – it was seen as part of a simple process of transmitting information (Field, 2003:20). Now, we recognize that it is an active process of receiving information, constructing meaning and also integrating it into what has already been understood. Therefore, reading is considered a receptive skill. It is important to note that readers are independent individuals who select what they want from a certain text. They make judgments about which parts appear most relevant to them. An (2013:130) argues that "efficient comprehension requires the ability to relate the textual material to one's own knowledge".

The reading process involves three stages. The first is the pre-reading stage, which allows the reader to preview the text, activate background knowledge, and develop a purpose for reading. The second stage takes place during reading – the reader makes predictions as he/she reads and then confirms or revises his/her predictions. The third stage occurs after reading and

it allows the reader to discuss the elements of a story, retell it or compare it to another text (study.com). Throughout the reading process readers use a variety of strategies to help them make meaning from a text. Some of the strategies are predicting, visualising, activating prior knowledge, drawing inferences, finding main ideas, evaluating, etc. According to Woolley (2011:114), "Knowledge of a story or text structure is often one of the most important elements in the comprehension of the narrative. For a text to be processed and understood, it must have a logical structure and contain cohesive devices to assist with the construction of mental models of the read text. For example, understanding time order sequences in text passages will help to facilitate the reader's ability to comprehend and logically organise the narrative."

To establish the differences between skilled and unskilled readers, it is important to mention lower level and higher level processes in reading. Lower level processes include decoding and accessing lexical entries. These processes are highly automatic in skilled readers. This means that such readers have enough Working Memory capacity left for higher level processes such as building general meaning, applying background knowledge to the text, inferring meaning which is not clearly stated in the text, interpreting the author's intentions, etc. (Field, 2003:25).

When it comes to the *context*, the reading researcher Keith Stanovich (1982) reviewed twenty-two different studies of reading, and concluded that they provided no clear evidence that good readers use context to enhance word recognition. However, skilled readers are more likely to recognise changes of topic in a text, enrich their comprehension by bringing in background knowledge and building a general meaning of a text rather than building it just at local (sentence) level. According to Stanovich (1980), context has two distinct functions in reading: a) it can be used to supplement partial or incomplete information from the text; and b) it can be used to enrich understanding. A less skilled reader has to rely more heaviliy on information provided by context in order to compensate for poor decoding skills, while a skilled reader only falls back upon top-down information to support decoding when the text is degraded through (for example) bad handwriting. (Field, 2003:121).

An important role is also assigned to the reader's schema knowledge.

2.1. Reader's schema

Our knowledge of the world is said to be stored in the form of schematas. The Schema Theory was first proposed in 1932 by the Cambridge memory researcher Sir Frederic Bartlett and it describes the process by which readers combine their own background knowledge with the information in a text to comprehend that text. Field defined the schema as "a set of interrelated features which we associate with an entity or concept" (2003:39). Simply put, Schema Theory states that all knowledge is organized into units (or schemata), where information is stored. This means that a schema is a generalized description or a conceptual system for understanding information – it is how knowledge is represented, stored, retrieved, and used (Meltzer, 2007:123). Kusiak-Pisowacka (2016:26) argues that "The schema controls text comprehension and selects micropropositions relevant to the gist of the text, which at the highest level of comprehension are transformed into one macroproposition (which might be, for example, a title of a text)".

According to Schema Theory, comprehending a text is an interactive process between the reader's background knowledge and the text. All readers carry in their minds different shemata, which are often culture-specific. The reader's schemata are organized in a hierarchical manner, with the most general at the top and the most specific at the bottom (An, 2013:130). A particular content schema may fail to exist for a reader because it is not part of a particular reader's cultural background. Furthermore, some key concepts may be absent in the schemata of some non-native readers, or they may carry alternate interpretations. New experiences incorporate more information into one's schema (Carell and Eisterhold, 1983:87). According to Anderson et al. (1979:2), a schema allows the reader to place the major themes, secondary themes, and supporting details in proper relation to one another, and may be integral to several other comprehension and memory functions. The reader uses two general types of schema in text interpreting. The first incorporates knowledge of discourse organization, and it is called a *textual schema*. The second type of schema includes the reader's existing knowledge of real and imaginary worlds, and it is called a *content schema*. Anderson et al. also believe that content schemata are more important for reading comprehension than textual schemata. Carell and Eisterhold (1983), on the other hand, defined schemata as reader's mental stores which are devided into three main types: content schemata, formal schemata and linguistic schemata. Formal schemata structures contain

knowledge of rethorical organization structures; content schema is the background knowledge of the content area of a text; and linguistic schemata include decoding features needed to recognize words and how they fit together in a sentence.
Field (2003:40) thinks that, when considering how readers process language information, it is useful to think in terms of three types of schema:
1. 'World knowledge'; including encyclopedic knowledge and previous knowledge of the writer. This helps us to construct a content schema for a text;
2. Knowledge built from the text so far; a current meaning representation.
3. Previous experience of this type of text (a text schema). This can be extended to include: previous experience of the type of task that the reader has to perform.

According to McNamara et al. (1991:493), "There is no doubt that readers use schemata in comprehension. It is not clear, however, what readers acutually do with schemata. Schema theorists have proposed that comprehension simply involves the instantation of schemata: readers activate a schema and fill in generic "slots" with the right text-specific information. But schema instantiation does not explain how or why readers understand texts about unfamiliar objects and events. A more general approach – one that can handle scripted and unscripted activities – is to view comprehension as a process of building and maintining a model of situations and events described in a text".

3. Memory

Cognitive psychologist Margaret W. Matlin (2005:23) has defined memory as the "process of retaining information over time.". Robert J. Sternberg (1999:187), psychologist and psychometrician, defined it as "the means by which we draw on our past experiences in order to use this information in the present".
In the broadest sense, there are three types of memory: sensory memory, short-term memory, and long-term memory. Atkinson and Shiffrin's model (1968) still remains the most popular model for studying memory. They suggested that there were three types of memory store:
1. Sensory register, which takes in sensory information and holds it for a very brief period of time, then decays and is lost;

2. Short-term store – it may be regarded as "the subject's *Working Memory"*; information entering the short-term store is assumed to decay and disappear completely, but much slower than for the sensory stage;
3. Long-term store – this store differs from the first two in that information stored here does not decay and become lost in some manner.
All information is eventually completely lost from the sensory register and the short-term store, whereas information in the long-term store relatively permanent (1968:14-17).

When reading a text, the reader retains an image of the word in their sensory store. The form of the word is passed to short-term memory, which stores current information. In order to identify the word, the reader needs to make a lexical search. Since short-term memory only holds temporary information needed for immediate purposes, lexical information has to be extracted from long-term memory. This means that the short-term memory is more than just a store - it is also responsible for language operations. For this reason, the term *Working Memory* is now usually preferred. Later, after processing a complete clause or sentence, the reader may want to store the piece of meaning they have acquired. In that case, they transfer it into long-term memory. (Field, 2003:19).

In this master's thesis, the focus is placed on Working Memory because it is extremely important when reading and recalling a text.

3.1. Working Memory

The term *Working Memory* was coined in the 1970s by British psychologists Baddeley and Hitch. According to Baddeley (2007:1), "Working Memory is assumed to be a temporary storage system under attentional control that underpins our capacity for complex thought". Working Memory holds information which is part of a current operation - this might be information retrieved from long-term memory (held temporarily for present use) or information from the environment. The main characteristic of Working Memory is that it has a very limited capacity for information. Working memory capacity refers to our ability to keep information either in mind or quickly retrievable, particularly in the presence of distraction. (Melby-Lervåg et al., 2016). There are limits to the amount of processing it can

undertake and to what it can store, which has important consequences for the way in which we process language. In order to avoid congestion in Working Memory, we constantly need to transfer useful information into long-term memory. Miller (1956) argued that Working Memory is only capable of holding about seven pieces of information (plus or minus two) at a time. This means that it is under pressure to chunk information (breaking up larger units into smaller ones); to shed verbatim information and replace it with abstract propositions (one complete idea instead of a number of words); and to transfer important information to Long Term Memory before it decays.

Baddeley and Hitch (1974) proposed their three-part Working Memory model as an alternative to the short-term store in Atkinson and Shiffrin's 'multi-store' memory model (1968), which was too simple in their opinion. Baddeley and Hitch's model was composed of three main components: the central executive, the phonological loop and the visuospatial sketchpad. In his article "The episodic buffer: a new component of working memory?", Baddeley (2000) added the fourth component to his model, the episodic buffer.
The most important component is the central executive, which is a limited capacity pool of general resources. It activates and regulates information form long-term memory and resolves possible conflicts between schema-controlled activities. The central executive is linked directly to two subsystems: the phonological loop and the visuospatial sketchpad. The phonological loop retains auditory information in time related serial order and it is responsible for temporary storage and processing of verbal information while visuospatial sketchpad is responsible for holding visual information in the form of a spatial representation. The episodic buffer acts as a temporary storage space where information from the other components are integrated. (Shahnazari-Dorcheh and Adams, 2013:19-20). This theoretical construct is useful for conceptualising how attention is allocated in Working Memory.
Sanford and Garrod (1981) and Garrod and Sanford (1988) have argued that Working Memory can be broken down into two focused partitions: explicit focus and implicit focus. Thematic subjects, protagonists, or explicitly mentioned subjects are maintained in explicit focus, whereas the situation described by the text is maintained in implicit focus. (O'Brien and Albrecht, 1992:782)

As it was already mentioned in the previous chapter, skilled readers' decoding is automatic. This leaves a great deal of Working Memory capacity free for considering contextual information and constructing higher level meaning. When it comes to less skilled readers, the

decoding process is more controlled (i.e. conscious) and slower. Therefore, the burden upon Working Memory is greater. The focus is put upon local rather than global meaning of the text. According to Woolley (2010:110), "... during reading, the ability to comprehend is enhanced when there is a reduction in the overall cognitive load in Working Memory. It is asserted that memory load is affected by how attention is allocated within and between the different component subsystems of Working Memory during a particular reading episode". Swanson (1992) studied Working Memory in skilled and less-skilled readers and he examined two theories regarding the relationship between Working Memory and poor reading skills. First, in Daneman's (1980) model, Working Memory resources are related to reading skill, in that readers with poor skills overload Working Memory capacity. The second theory of interest to Swanson was Turner and Engle's model (1989), which suggests that the Working Memory capacity of poor readers is smaller than that of strong readers. This means that Working Memory capacity is independent of reading skill, and therefore weaker working capacity is not a consequence of poor reading skills, but that the lower capacity leaves fewer resources available for performing reading and non-reading tasks (Perry and Malaia, 2013:4).

Field (2013:172) argues that "the greater our expertise in a particular sphere, the greater is our Working Memory capacity for information in that sphere." The expert knowledge enables very efficient coding and retrieval of information within the certain area of expertise. He further argues that "memory skills clearly do rely on the short-term Working Memory, but expertise greatly facilitates activation of relevant information in the knowledge base, and this activated knowledge can offer significant support for the more limited temporary Working Memory system."

Virginia Rosen and Randall Engle (1997) speculated that Working Memory capacity is related to one particular form of language skills – specifically, people's general level of verbal fluency. People who are extremely fluent speak without hesitation, and they seem to be able to retrieve a large variety of words with little difficulty. In contrast, others speak more hesitantly, and their vocabulary is more limited. Furthermore, a research by Atkins and Baddeley (1998) shows that Working Memory performance is related to the ability to learn vocabulary in a foreign language (Matlin, 2005:123).

One of the aims of this thesis is to examine the differences in Working Memory capacity between 3 groups of participants - native speakers of English, native speakers of Croatian without a degree in English language, and native speakers of Croatian who either have a

degree in or are students of English. Abundant research has examined the relationship between Working Memory and bilingualism. As stated by Calvo et al. (2016), some studies (Feng, 2009; Namazi and Thordardottir, 2010; Bonifacci et al., 2011; Engel de Abreu, 2011) have reported no Working Memory differences between bilinguals and monolinguals.

However, other studies reported advantages and disadvantages for bilinguals. One of the studies which has reported advantages for bilinguals was the one made by Bialystok et al. (2004), who compared bilingual and monolingual adults (aged 30–80) in three different studies using a non-verbal Simon task[1]. Overall, bilinguals outperformed monolinguals when Working Memory demands were high, and the extent of the difference was proportional to age. Further evidence for a bilingual Working Memory advantage was reported by Morales et al. (2013) in two experiments with children. To this end, the authors used a Simon-type task and a visual-spatial task. Their overall results showed that bilinguals surpassed monolinguals in all the conditions involving high Working Memory and executive demands.
It is, on the other hand, also believed, that bilinguals' dual language processing imposes a heavier cognitive load on their Working Memory. One of the studies wich substantiate this claim was conducted in 2004 by Tokowicz, Michael, and Kroll, who suggest that bilinguals might have a disadvantage in terms of their Working Memory function because of their heavy language load from two activated languages (Yang, 2017:1).

There have been many attempts to use training procedures to increase Working Memory capacity, and consequently the performance on the real-world tasks which rely on Working Memory capacity. Although traditionally viewed as an immutable aptitude, more recently Working Memory has been shown to improve with training (e.g., Thompson et al., 2013). According to Constantinidis and Klingberg (2016), effects of Working Memory training include increases in the activity of neurons. Neural changes after training are found in cortical areas that process spatial information in Working Memory and attention, potentially providing a basis for transfer to other cognitive and behavioral tasks that rely on spatial Working Memory and spatially selective attention. Johnson (2013:6) claims that "Newly developed training paradigms have been used widely in the assessment of working memory capacity and the training to enhance performance of working memory". Recent studies in the fluidity of

[1] The Simon task is based on stimulus–response compatibility and assesses the extent to which the prepotent association to irrelevant spatial information affects participants' response to task-relevant nonspatial information (Bialystok et al., 2004:291)

mental processes have shown the benefits of working memory training programs (Jaeggi et al., 2008).

After thoroughly explaining the procedure of my research in chapter 5, the gathered results will be analyzed and compared across the 3 different groups of participants mentioned above, in order to see if there is any difference in their Working Memory capacity.

4. Meaning representation

The minds of readers are actively engaged in constructing a meaning representation on the basis of the evidence they receive. "A meaning representation can be understood as a bridge between subtle linguistic nuances and our common-sense non-linguistic knowledge about the world. It can be seen as a formal structure capturing the meaning of linguistic input." (Khetan, 2019). Once the readers have built such a representation for a current sentence, they have to attach it to what they had previously read. This means that the receptive skills involve not just constructing meaning but also integrating it into what has already been understood. Readers, who are independent individuals, select what they want from a text. They make judgements about which parts appear most relevant to them, or which parts constitute major pieces of information and which are minor. Their judgements may be different from the intentions of the writer. Since they sometimes have to guess the intentions of the writer, they do not simply receive a message; they have to remake it. The process of producing or understanding language involves taking linguistic information through a series of stages (levels of representation) and changing it at each step (Field, 2003:20). Readers seem to construct meaning instinctively. "Where the information in a text is incomplete, the reader or listener will often flesh it out with their own inferences in order to construct a neat representation. Meaning representation is provisional - it is subject to revision as new information comes in. A large part of the effort of processing a text is said to lie in the need to integrate incoming information into an existing representation." (Field, 2003:82).

For example, the sentence *Blood from the wound to the head had soaked into a Persian rug* is processed on three levels, as suggested by Field (2003:83).

1. Surface form: the wording of the sentence.
2. Propositional form: the literal meaning of the sentence

3. A mental model: this representation includes additional information from world knowledge; it also includes drawing inferences.

Persian rug: it engages our world knowledge; we know that Persia is a historic Asian region; we know that Persian rugs have specific colors and patterns, they are made of high-quality materials; we know that they are expensive.

4.1. Mental Models

According to Woolley (2010:110), "the way a mental model is constructed may be largely determined by the architecture of memory and the reader's ability to effectively operationalise a number of processes simultaneously and to bind or link visual and verbal information in Working Memory". Mental models can be defined as mental representations of how a knowledge domain is organized (Riemer and Schrader, 2019). They are flexible representations that are constantly updated to reflect the most recent conceptualisations of read text information (Woolley 2010:119). To put it simply, a mental model is an explanation of someone's thought process about how something works in the real world. People use mental models during reading comprehension as the basis for their understanding.

The construction of a mental model is a dynamic constructive process, partly determined by the interaction of the reader with the text structure and story content. The mental model is goal directed and predictions are made about upcoming story events, which may be adjusted to incorporate unexpected scenarios (Woolley, 2010:109). The creation of a coherent mental model is the goal of comprehension. It is important to note that readers are selective and that mental models they construct often reflect their own individual sense of what is important in the information they have received. Also, the construction and manipulation of a mental model is limited by Working Memory capacity. "When people encounter new information, they construct a mental model of the unfamiliar topic area. If a topic is wholly unfamiliar to learners, they lack a structure for thinking about it and are unsure how to prioritize, store, or interpret the information. They may borrow from a familiar schema related to the new topic to process the unconnected information. Or they may ignore it." (Heeter et al., 1997). According to O'Brien and Albrecht (1992:777), "it has generally been assumed that the reader adopts the

perspective of the protagonist, maintaining information (i.e. actions, events, thoughts, and objects) relevant to the protagonist's point of view".

Although most research in the 20th century was concerned with motor processes, more and more attention was paid to mental processes in reading. The studies of Kintsch (1974) and Meyer (1975) provided evidence that the comprehension process is affected by text structure. The key notions of Kintsch's model are propositions, which may be defined as "ideas that can be expressed in words, not the words themselves" (McNamara et al., 1991:492). The theory of reading based on propositions was met with criticism. According to Kusiak-Pisowacka (2016:25-26), a problem was noticed with propositional representations because they are often more representative of the structure of the text than they are of the structure of memory for the text. The importance of the reader's prior knowledge in reading comprehension came to light again. The schema theory also began to be criticised. Certain limitations of the theory were noticed and the question of why and how readers understand texts about unfamiliar events was raised. Thus, a need arose for a more general approach viewing reading as a process of building and maintaining comprehension of situations described in a text. Such an approach was suggested by mental model theories, which view reading as a process of building and maintaining comprehension of the situations described in a text. They enrich the view of text representation suggested by earlier models.

Kusiak-Pisowacka (2016:35) further argues that mental models have a number of advantages. In contrast to earlier models, "they elucidate dynamic relationships between text structure properties and the reader's background knowledge. They focus on both the writer and the reader, describing the strategies that the writer applies to communicate his/her ideas as well as factors that influence the reader's construction of text representation". Readers are sometimes satisfied with incomplete mental models which are sufficent for their purposes because of the complexity of the information they have to process or because their task only requires them to process a text at a relatively shallow level. (Field, 2003:86). Britton (1994:644) claims that "the mental structures that readers derive from a text often will be incomplete or incorrect, when compared to the structure intended by the author".

According to McNamara et al. (1991:494), a mental model built by the reader in the process of reading consists of "mental tokens arranged in a structure that depicts the situations described by a text". They claim that readers are able to process a text either as a set of

propositions or as a mental model: "Readers emphasize propositional encoding, retaining text structure when they want to remember the text material verbatim. They also use propositional encoding when the indeterminate nature of the text makes mental model construction difficult. However, when the text material is conductive to mental model processing, as in task instructions, narrations, or spatially determinate descriptions, people avail themselves of its benefits. Mental models do not retain text structure but can support better recall of events described by a text." (1991:495). Mani and Johnson-Laird (1982:185) said that a mental model should be easier to remember than a propositional representation. They distinguished two modes of encoding: "mental models, which are easier to remember but contain no information about the specific sentences on which they are based, and propositional representations, which are harder to remember but do distinguish between such assertions as "A is to the right of B" and "B is to the left of A".

When it comes to skilled readers, they use the largest, most general existing schema frame to construct mental models, by organising their stories into schemas with settings, plots, and episodes. This means that a skilled reader may activate the most appropriate stored schema to facilitate the organisation of read text information together with the retrieval of linked memory information. In this way a skilled readers' comprehension of the read text is directly associated with, and influenced by their own past experiences (Woolley, 2010:115).

Mental model theories have also contributed to studies which explore differences between the first language (L1) and foreign language (FL) reading. Jenkin, Prior, Richard, Wainwright-Sharp, and Bialystok (1993) found that readers were able to form propositional relations and develop mental models in their L1. However, in their FL only propositional networks were developed. The researchers concluded that the content information is represented differently in text memory during L1 and FL processing (Kusiak-Pisowacka, 2016:30).

4.2. Inference

Constructing a mental model using previously learned or schematic knowledge requires the reader to make inferences about the situations in the text. An inference is a conclusion we draw or opinion we form about something by using information we already have about it.

A written text includes only part of the information required for comprehension. Where the information in a text is incomplete, the reader or listener will often flesh it out with their own inferences in order to construct a neat representation (Field, 2008:82). According to Blanchard and Brewer (1983:1), there are an unlimited number of inferences which could be made in the process of comprehension. Therefore, there must be some mechanism for controlling inferences. Various solutions to this problem of constraining inferences have been proposed. Schank (1979) proposed that inferences are made if they are interesting, while Goetz (1979) proposed that inferences are made if they are important in the structure of the text. Corbett and Dosher (1978) proposed that inferences are made if they are highly probable.

Based on a review of the literature Alba and Hasher (1983), concluded that there was little empirical support for schema theories that predicted large numbers of inferences (McNamara et al., 1991:497).

Here are two simple examples of inference:

a) Elza is a horse and all horses like carrots. So, Elza must love carrots.
b) Hannah takes a bus to work every morning; she obviously doesn't know how to drive or doesn't own a car.

The first sentence is an example of good inference while the second sentence is the example of a faulty inference. A faulty inference is when we come up with a false conclusion based on valid evidence. The second sentence is a concrete example of a false dichotomy. A false dichotomy happens when we assume that there are only two possibilities that could be valid, when in reality, there are far more that we simply aren't aware of (Wiest, 2019).

Johnson-Laird claims that people can detect invalid inferences by coming up with counterexamples. He emphasizes that there are two types of invalid inferences: first, that the conclusion is inconsistent with the premises (people seem to be able to detect this inconsistency), and second, the conclusion is consistent with the premises but does not follow from them (people come up with a counterexample). He says that people confidently make illusory inferences which are invalid. In particular, "when they think about the truth of one assertion, they fail to think about the consequences of the falsity of other assertions". (2012:141-142)

Johnson-Laird (1983) distinguishes between two sorts of inferences that occur in daily life:
1. Inferences which mostly require a conscious and cold-blooded effort and we must make a voluntary decision to try to make them; they may take time and they are at the forefront of our awareness: they are explicit.
2. Inferences that underlie the more mundane processes of intuitive judgement and the comprehension of discourse; they tend to be rapid, effortless and outside conscious awareness: they are implicit.

He gives the following example:

(i) *There was a fault in the signalling circuit. The crash led to the deaths of ten passengers...*

We might infer that the passengers were killed in the crash. However, the text does not make this assertion, and it might even continue:

(ii) *Because they were arrested after the accident, and subsequently shot as spies.*

Plainly, we jumped to a conclusion based partly on the content of the passage and partly on our general knowledge. We make such inferences automatically, almost involuntarily, and often without being aware of what we are doing. "Since a valid inference is one for which, if the premises are true, the conclusion must be true, an important feature of these inferences is that they are usually invalid." (1983:127)

Field (2003:132-133), on the other hand, distinguishes between bridging and elaborative inference. The bridging inference is inference necessary to an understanding of the text. Bridging inferences are necessary for comprehension and make a vital link between two pieces of information. However, not all inferences are as essential for understanding; some of them only amplify what is in a text, and they are called elaborative inferences. The bridging/elaborative distinction is not always an easy one to make. Some researchers believe that bridging inferences feed into the mental models which we construct, whereas elaborative inferences do not.

According to Field (2003:85), "subjects find it difficult to distinguish between propositional information and the inferences which they have added to that information". One of the studies which support his claim is that by Bransford, Barclay and Franks (1972). They showed that subjects who memorized sentence (1) later had difficulty deciding whether they had learned that sentence or a similar sentence, sentence (2):

(1) *Three turtles rested on a floating log, and a fish swam beneath them*.
(2) *Three turtles rested on a floating log, and a fish swam beneath it.*

According to a propositional analysis, these sentences differ by a single proposition; namely, the proposition that specifies whether the fish swam under the turtles or under the log. Given that the sentences differ by a single proposition, the memory confusions are not very surprising. However, subjects who memorized sentence (3) did not confuse it with sentence (4):

(3) *Three turtles rested beside a floating log, and a fish swam beneath them.*
(4) *Three turtles rested beside a floating log, and a fish swam beneath it.*

These sentences differ by the same proposition that distinguishes sentences (1) and (2). According to a propositional analysis, sentences (3) and (4) should be just as confusable as sentences (1) and (2). The difference between these pairs of sentences lies in the situations they describe. Sentences (1) and (2) describe the same event in the world. Sentences (3) and (4), however, describe different events. If subjects mentally represented the sentences as models of the situations, then the confusions make sense. Mental models of sentences (1) and (2) would be identical, but mental models of sentences (3) and (4) would be quite different. (McNamara et al., 1991:493-494.).

Research into mental models has especially focused on the way in which we form **spatial representations** based on what we read or hear, because mental model processing seems predominant in spatial descriptions. There are many simple, everyday tasks, such as following road directions, using instructions to assemble a piece of furniture, or reading a novel, that seem to require the construction of a spatial mental model from a description. According to Tversky (1991:109), in order to comprehend instructions like go *straight till the first light, then turn left, after 500 meters, turn right*, it is useful to have a spatial representation. Of course, the gist of the message could be remembered instead, but incorporating the

instructions into a mental model helps, especially when things don't quite turn out as expected, such as encountering a "no left turn" sign at the light.

As stated by Baguley (1994:1), "Spatial relations are one of the most fundamental, if not the most fundamental, example of the structural relations that the human mind is capable of representing and understanding. Mental models of the structure of spatial situations are referred to as spatial mental models".

Readers of spatial descriptions spontaneously construct spatial mental models of the described scenes as a natural consequence of reading for comprehension and memory, with no special training, instructions, or prior visual displays. However, readers do not necessarily construct spatial models from every text; in order to construct a spatial model, the text must be spatial, coherent, well integrated, and more or less determinate, among other characteristics. The constructed spatial mental models reveal people's conceptions of space. (Tversky, 1991:141).

McNamara et al. (1991:497) stated that "Readers seem to focus on information relevant to the main character in a narrative, recording and updating spatial relations between the protagonist and objects with which he or she interacts. Readers also make perspective shifts from one character to another as the situation requires. While updating mental models, readers often must retrieve episodically learned information. Available data indicate that readers can retrieve episodically learned information (e.g., spatial relations depicted in a map) if it aids in understanding the situation described by a narrative".

O'Brien and Albrecht (1992) demonstrated that readers are sensitive to the location of a protagonist. Information inconsistent with that location, even when presented much later in the text, slowed reading.

A classic experiment by Mani and Johnson-Laird (1982) manipulated the determinacy of spatial descriptions in order to investigate how people represent and remember spatial information. They found that subjects used different encoding strategies, depending on whether they were reading a spatially determinate description or a spatially indeterminate description[2].

According to Graesser et al., "adult readers routinely generate only a small set of inferences, rather than promiscuously generating many classes of inferences. Readers routinely generate inferences that involve explanations, passive-activations, readers' goals, and coherence (the

[2] Determinate descriptions permit the construction of a single mental model which supports gist recall. For indeterminate descriptions the construction of a single consistent mental model is not possible, therefore people abandon their attempt to construct a mental model and concentrate on remembering the description itself. (Baguley, 1994:48)

latter perhaps being confined to readers who have high reading fluency). Readers do not tend to generate inferences that involve detailed elaborations (e.g., spatial layout, visual features of objects and people, the manner in which actions and events occur), distant causal consequences, logical syllogisms, and statistics. Instead of assuming that "anything goes", there are constraints from cognition, the world environment, and perhaps biology that limit the classes of inferences that are generated." (2001:8).
Skilled readers often employ inference in order to add to or enrich the literal information provided by a text. They are are likely to make inferences by incorporating relevant background knowledge to make sense of implicit information found within texts to enhance understanding. (Woolley, 2010:109).

A big problem in inference literature is the question of whether inferences are made at the time of comprehension or afterwards, at the time of test or recall. "It is clear that inferences can be made at both points in time. Those inferences involved in the construction of a mental model are generated at comprehension. However, any inference about the text can be made at test time, if the demands of the task require that it be made." (Blanchard and Brewer, 1983:7). Many studies on inferencing have been criticized because they can't determine whether an inference was made during encoding or at the time of the memory test (McNamara et al., 1991:497).

The primary focus of this paper is to prove that all readers make incorrect inferences besides the correct ones when reading and recalling a text. Readers make incorrect inferences as part of their construction of a mental model, which is a finding that has been repeated many times in meaning-building experiments (Field, 2003:85). I will try to prove this hypothesis in my reaserch, in the following chapters.

5. Research

The main focus of this research is to demonstrate that all readers will make a number of incorrect inferences besides the correct ones when reading and recalling a text.

The second purpose of the research is to see if there is any difference in Working Memory capacity between 3 groups of participants - native speakers of English, native speakers of Croatian without a degree in the English language, and native speakers of Croatian who either

have a degree in English or are students of English. Some linguists (Bialystok et al. 2004, Morales et al. 2013) reported advantages for bilinguals, while others (Yang, 2017) stated that bilinguals' dual language processing imposes a heavier cognitive load on their Working Memory.

5.1. Participants

The research involved 120 participants. They were divided into three groups:

1. Native speakers of English – labeled as Group 1;
2. Native speakers of Croatian without a degree in the English language – labeled as Group 2;
3. Native speakers of Croatian who either have a degree in English or are students of English at the Faculty of Humanities and Social Sciences in Zagreb – labeled as Group 3.

	Group 1	Group 2	Group 3
Age range	22-72	20-55	20-33
Average age	42.3	28.3	23.9

The age range of all participants in groups 1, 2 and 3 is 20-72, and the average age is 31.5.

5.2. 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 text used in the research, with slight changes, was taken from John Field's book *Psycholinguistics, a resource book for students* (2003:84).

After reading the text, the participants were asked to fill in a questionnaire. The first part of the questionnaire was related to the previously read text. The participants had to tick pieces of information for which they believed evidence had been provided in the text. The purpose of the rest of the questionnaire was to find out some personal information about the participants, which providided me with the information on their age, foreign language proficiency and level of linguistic education. This personal information was needed in order to determine whether participants who are bilingual or fluent in a foreign language would be better or worse at solving the given task compared to participants who do not fluently speak a foreign language(s). The research was anonymous.

Both the questionnaire and the text were prepared in English and Croatian. The English text consisted of 250 words, while the Croatian translation of the text consisted of 207 words. The layout of the text was the same as in the original (English) version.

All of the materials that were used in this research are given in Appendix 1.

5.3. Procedure

The research was conducted online and it consisted of two parts. For the first part of the research, the participants were sent a link to the text, which they were required to read carefully. Groups 1 and 3 were given the text in English, while Group 2 got the text in Croatian. Each group was informed they had 2 minutes to complete this task.

For the second part of the research, the participants were provided with a link to the questionnaire and were asked to fill it in. Groups 1 and 3 got the questionnaire in English, while Group 2 got the questionnaire in Croatian. The first task in the questionnaire was to tick the pieces of information (1-17) for which, to their belief, evidence was supplied in the text. The participants were asked not to look at the text, and to remember that the issue was not whether those exact words were used, but whether the evidence was provided in the text. The rest of the questionnaire consisted of questions about the age of participants, their formal linguistic education, fluency in foreign languages and their opinion about the read text.

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 under the name *Mental Models and Inference in Reading Comprehension,* at the Department of English, Faculty of Humanities and Social Sciences in Zagreb. This was in order not to influence the results of the research. The participants were all informed that the research was anonymous and their participation voluntary.

5.4. 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 that all readers make incorrect inferences besides the correct ones was true.

The results of the research will focus on a number of facts that the participants thought were supplied in the text. They were offered 17 facts to choose from (multiple-choice). In the text, they were specifically told only five of these facts - 2, 6, 7, 11 and 14. Anything else, they inferred as part of their construction of a mental model. Based on the results, I will see if any of the groups (1, 2 and 3) have a higher working memory capacity than the other groups.

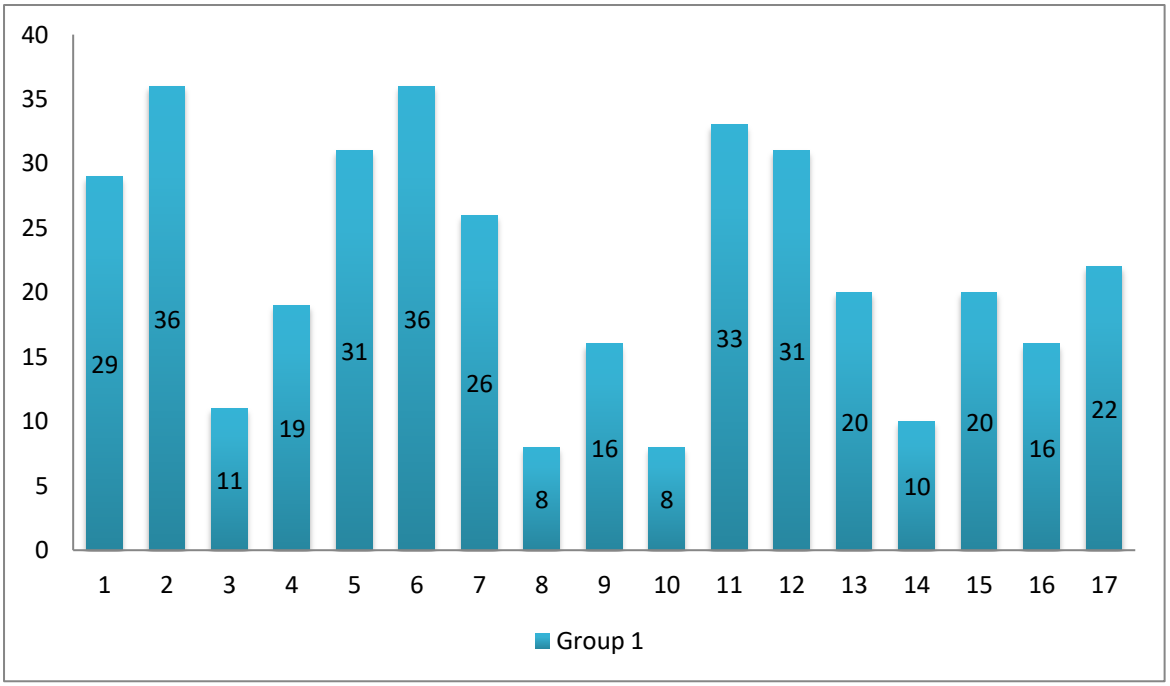
5.4.1. Group 1

Group 1 consisted of 40 native speakers of English.

Group 1	
Average age	42.3
Speak fluently a foreign language(s)	12 (30%)
1 foreign language	7
2 foreign languages	4
3 foreign languages	1
Have a degree in a foreign language or linguistics	4 (10%)
Speak 2 native languages	8 (20%)

10% of the participants thought that the text was not simple and clear.

The data gathered from Group 1 show that the participants marked an average of 9.3 facts as correct, i.e. they believed that evidence for those facts had been provided in the text.



1) 29 – 72.5%; 2) 36 – 90%; 3) 11 – 27.5%; 4) 19 – 47.5%; 5) 31 – 77.5%; 6) 36 – 90%; 7) 26 – 65%; 8) 8 – 20%; 9) 16 – 40%;10) 8 – 20%; 11) 33 – 82.5%; 12) 31 – 77.5%; 13) 20 – 50%; 14) 10 – 25%; 15) 20- 50%; 16) 16 – 40%; 17) 22 – 55%.

As already mentioned, in order to solve the task correctly, the participants should have ticked only five facts – facts 2, 6, 7, 11, 14, and no one ticked only those five facts.

Only 25% of the participants of Group 1 marked fact 14 (the lowest score among the correct answers).

Fact 14 in the task: *There were two windows to the library.*

The sentence from the text: *Holmes pulled back the heavy curtains in front of one of the two windows in the room...*

Conclusion: the participants didn't realize that the room referred to the library, possibly because it was a new paragraph; or they constructed a mental model of a room (e.g. bedroom), because the exact word 'library' wasn't used in this sentence in the text.

The most marked incorrect answers are 1 (72.5%), 5 (77.5%) and 12 (77.5%).

Fact 1: *The sitting room was next to the library.*

Sentence from the text: *The library was between the dining room and the sitting room.*

Conclusion: the participants created a spatial representation as part of their mental model, and they envisioned the library being next to the sitting room since it was between the sitting room and the dining room. Consequently, this made them think that there were no other rooms between the library and the sitting room. This is a concrete example of a false dichotomy, which happens when we assume that there are only two possibilities that could be valid, when in reality, there are far more that we simply aren't aware of.

Fact 5: *Nobody had heard any noise from the library.*

Sentence from the text: *...nobody reported hearing voices from the library.*

'To hear' and 'to report hearing' is not the same thing (direct vs. indirect evidence), and the participants ignored this difference in meaning when constructing a mental model. Also, two different nouns were used in the text and in fact 5; hearing noise and hearing voices in this context are similar notions, which may also be confusing. However, according to the results, it is evident that most of the participants did not notice neither the use of different verbs nor nouns. This may be due to the fact that the respondents only read the text once, and because of the large amount of information present in the text, they were only able to remember that there was silence in the library (but no other details).

Fact 12: *The body was lying on a rug.*

Sentence from the text: *Blood from the wound to the head had soaked into a valuable Persian rug.*

Conclusion: the participants wrongly inferred that the body was lying on a rug, because the blood from that same body soaked into a rug. They automatically jumped to the wrong conclusion.

5.4.2. Group 2

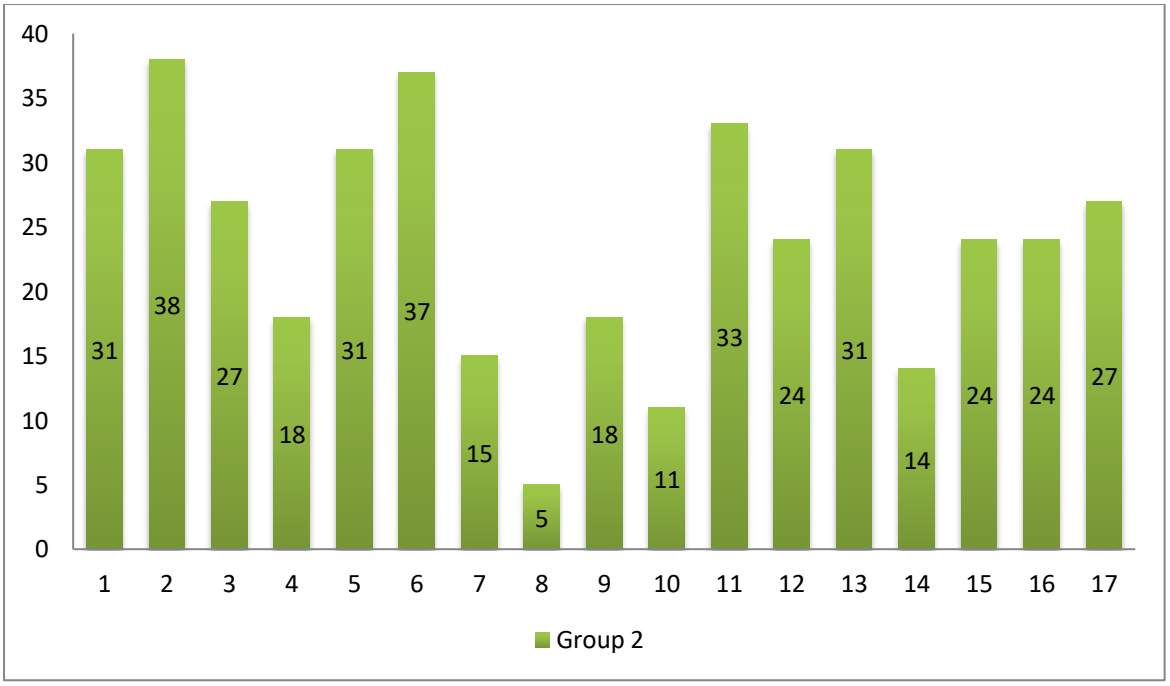
Group 2 consisted of 40 native speakers of Croatian.

Group 2	
Average age	28.3
Speak fluently a foreign language(s)	35 (87.5%)

1 foreign language	25
2 foreign languages	9
more than 3 foreign languages	1
Have a degree in a foreign language (other than English) or linguistics	2 (5%)
Speak 2 native languages	0

5% of the participants thought that the text was not simple and clear.

The data gathered from Group 2 show that the participants marked an average of 10.2 facts as correct i.e. they believed that evidence for those facts had been provided in the text.



1) 31 – 77.5%; 2) 38 – 95%; 3) 27 – 67.5%; 4) 18 – 40%; 5) 31 – 77.5%; 6) 37 – 92.5%; 7) 15 – 37.5%; 8) 5 – 12.5%: 9) 18 – 40%; 10) 11 – 27.5%; 11) 33 – 82.5%; 12) 24 – 60%; 13) 31 – 77.5%; 14) 14 – 35%; 15) 24 – 60%; 16) 24 – 60%; 17) 27 – 67.5%.

In order to solve the task correctly, the participants should have ticked only five facts – facts 2, 6, 7, 11, 14, and no one ticked only those five facts.

Only 37.5% of the participants of Group 2 marked fact 7, while 35% marked fact 14 (the lowest score among the correct answers).

Fact 7: *Kamin se nalazio lijevo od tijela.*

Sentence from the text: *U knjižnici je bio veliki kamin, a tijelo je ležalo desno od njega.*

Conclusion: the participants had a problem remembering a spatial description.

Fact 14: *U knjižnici su bila dva prozora.*

The sentence from the text: *Holmes je povukao teške zavjese ispred jednog od dva prozora u sobi i pažljivo pregledao prozor.*

Conclusion: the participants didn't realize that the room referred to the library, possibly because it was a new paragraph; or they constructed a mental model of a room (e.g. bedroom), because the exact word 'library' wasn't used in this sentence in the text.

The most marked incorrect answers are 1 (72.5%), 5 (77.5%) and 13 (77.5%).

Fact 1: *Dnevni boravak se nalazio kraj knjižnice.*

Sentence from the text: *Knjižnica se nalazila između blagovaonice i dnevnog boravka.*

Conclusion: the participants created a spatial representation as part of their mental model, and they envisioned the library being next to the sitting room since it was between the sitting room and the dining room. Consequently, this made them think that there were no other rooms between the library and the sitting room. This is a concrete example of a false dichotomy, which happens when we assume that there are only two possibilities that could be valid, when in reality, there are far more that we simply aren't aware of.

Fact 5: *Nitko nije čuo buku iz knjižnice.*

Sentence from the text: … nitko nije prijavio da je čuo glasove iz knjižnice.

'To hear' and 'to report hearing' is not the same thing (direct vs. indirect evidence), and the participants ignored this difference in meaning when constructing a mental model. Also, two different nouns were used in the text and in fact 5; hearing noise and hearing voices in this context are similar notions, which may also be confusing. However, according to the results,

it is evident that most of the participants did not notice neither the use of different verbs nor nouns. This may be due to the fact that the respondents only read the text once, and because of the large amount of information present in the text, they were only able to remember that there was silence in the library (but no other details).

Fact 13: *Vaza je bila razbijena.*

Sentence from the text: *Stol je bio prevrnut, a vaza srušena na popločani pod. Svjetiljka je bila razbijena.*

Conclusion: using their previous knowledge and experience, the participants wrongly inferred that a vase surely had to be broken if it fell on the tiled floor. They ignored the fact that the vase does not have to be fragile (made from glass or ceramic) and that there is a possibility that it was not broken. The other possibility is that they have mistaken the lamp for a vase.

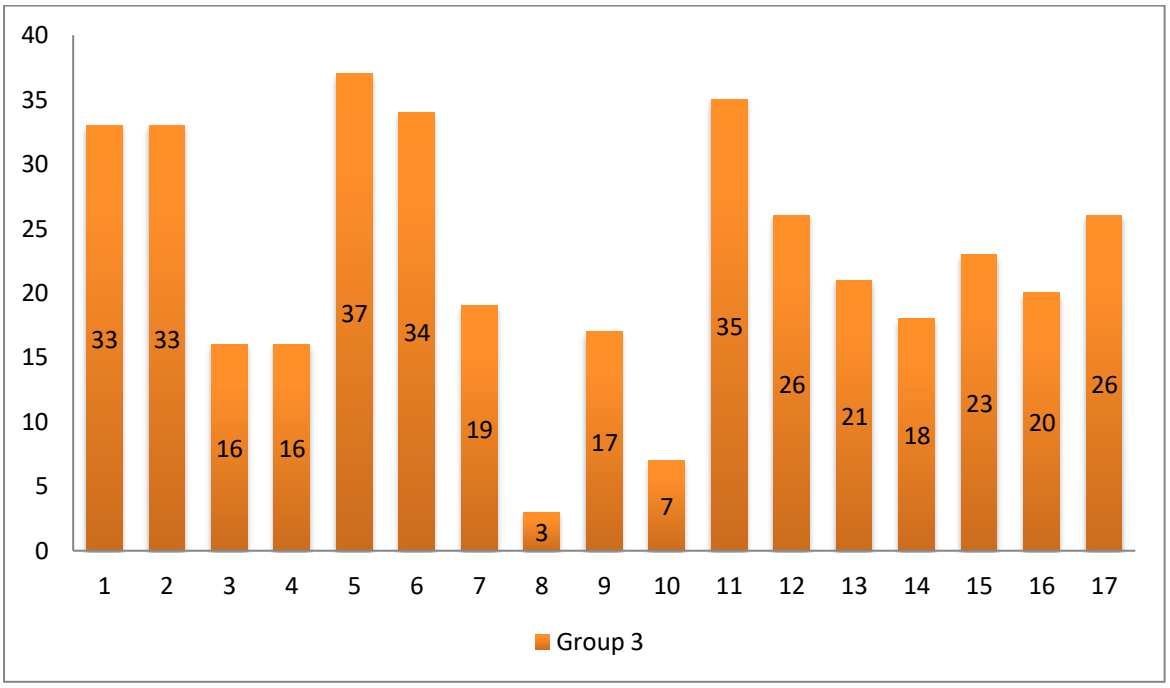
5.4.3. Group 3

Group 3 consisted of 40 native speakers of Croatian who either have a degree in English or are students of English, all of whom are (former) students at the Faculty of Humanities and Social Sciences in Zagreb. The participants of this group are considered to be sequential bilinguals as they are highly proficient in English.

Group 3	
Average age	23.9
Speak fluently a foreign language(s)	21 (52.5%)
1 foreign language	18
2 foreign languages	3
Have a degree in a foreign language (other than English) or linguistics	18 (45%)
Speak 2 native languages	1 (2.5%)

7.5% of the participants thought that the text was not simple and clear.
32.5% of the participants thought it would have been easier to complete the task in their native language.

The data gathered from Group 3 show that the participants marked an average of 9.6 facts as correct i.e. they believed that evidence for those facts had been provided in the text.



1) 33 – 82.5%; 2) 33 – 82.5%; 3) 16 – 40%; 4) 16 – 40%; 5) 37 – 92.5%; 6) 34 – 85%; 7) 19 – 47.5%; 8) 3 – 7.5%; 9) 17 – 42.5%; 10) 7 – 17.5%; 11) 35 – 87.5%; 12) 26 – 65%; 13) 21 – 52.5%; 14) 18 – 40%; 15) 23 – 57.5%; 16) 20 – 50%; 17) 26 – 65%.

Since only five facts (2, 6, 7, 11, 14) were the correct answers, no one solved the task successfully - no one ticked only those five facts.

Only 47.5% of the participants of Group 3 marked the fact 7 as correct, while 40% marked the fact 14 as correct (the lowest score among the correct answers):

Fact 7: *There was a fireplace to the left of the body.*

Sentence from the text: *There was a large fireplace in the library and the body was lying to the right of it.*

Conclusion: the participants had a problem remembering spatial descriptions.

Fact 14: *There were two windows to the library.*

Sentence from the text: *Holmes pulled back the heavy curtains in front of one of the two windows in the room…*

Conclusion: the participants didn't realize that the room referred to the library, possibly because it was a new paragraph; or they constructed a mental model of a room (e.g. bedroom), because the exact word 'library' wasn't used in this sentence in the text.

The most marked incorrect answers are 1 (82.5%) and 5 (92.5%).

Fact 1: *The sitting room was next to the library.*

Sentence from the text: *The library was between the dining room and the sitting room.*

Conclusion: the participants created a spatial representation as part of their mental model, and they envisioned the library being next to the sitting room since it was between the sitting room and the dining room. Consequently, this made them think that there were no other rooms between the library and the sitting room. This is a concrete example of a false dichotomy, which happens when we assume that there are only two possibilities that could be valid, when in reality, there are far more that we simply aren't aware of.

Fact 5: *Nobody had heard any noise from the library.*

Sentence from the text: *…nobody reported hearing voices from the library.*

'To hear' and 'to report hearing' is not the same thing (direct vs. indirect evidence), and the participants ignored this difference in meaning when constructing a mental model. Also, two different nouns were used in the text and in fact 5; hearing noise and hearing voices in this context are similar notions, which may also be confusing. However, according to the results, it is evident that most of the participants did not notice neither the use of different verbs nor nouns. This may be due to the fact that the respondents only read the text once, and because of the large amount of information present in the text, they were only able to remember that there was silence in the library (but no other details).

	NATIVE SPEAKERS OF ENGLISH	NATIVE SPEAKERS OF CROATIAN	NATIVE SPEAKERS OF CROATIAN WITH A DEGREE IN ENGLISH / STUDENTS OF ENGLISH
1	72.5%	77.5%	82.5%
2	90%	95%	82.5%
3	27.5%	67.5%	40%
4	47.5%	40%	40%
5	77.5%	77.5%	92.5%
6	90%	92.5%	85%
7	65%	37.5%	47.5%
8	20%	12.5%	7.5%
9	40%	40%	42.5%
10	20%	27.5%	17.5%
11	82.5%	82.5%	87.5%
12	77.5%	60%	65%
13	50%	77.5%	52.5%
14	25%	35%	40%
15	50%	60%	57.5%
16	40%	60%	50%
17	55%	67.5%	65%

Comparison of the results of Group 1, Group 2 and Group 3

6. Discussion

The results obtained in this research across all three groups confirm the primary hypothesis that all readers make some incorrect inferences besides the correct ones, regardless of their age, education, reading skills, and the ability to speak foreign languages perfectly. In order to solve the task correctly, the participants should have ticked only five facts – facts 2, 6, 7, 11, 14, and no one out of 120 participants ticked only those five facts. Every other fact they ticked, the participants inferred as part of their construction of a mental model. In chapter 5, it was mentioned that readers are able to process a text either as a set of propositions or as a mental model. The readers emphasize propositional encoding when they want to remember the text material verbatim and when the indeterminate nature of the text makes mental model construction difficult. However, when it comes to, narrations, spatially determinate descriptions, etc., people will process a text as a mental model. Participants in this research weren't instructed to memorize the text, but to read the text carefully. From the large number of incorrect inferences, it is clear that they processed the text as a mental model. Mental models do support better recall of events described by a text. However, constructing a mental model for the reader will make them more likely to remember parts of the text that they find more important. Propositional representations are harder to remember but they do distinguish

between certain details in a text. This is why the participants could not remember e.g. if the fireplace was to the left or to the right of the body.

The data gathered from Group 1 show that the participants marked an average of 9.3 facts as correct i.e. they believed that evidence for those facts had been provided in the text , Group 2 marked an average of 10.2 facts as correct, while Group 3 marked an average of 9.6 facts as correct. Particularly problematic facts were 1, 5 and 14 in all three groups.

As it was already mentioned, I expected the native Croatian speakers who either have a degree in English or are students of English, to 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. This is because the more experience we have with studying and remembering the second language, the easier it is for us to access our memory. Not only does regular study of a second language help protect memory, but it also promotes and maintains the active process of retrieving information stored in our brain (optilingo.com). Being fluent in a foreign language can help us focus more on the task at hand. A research by Zhou and Krott (2018) that was carried out on bilingual people showed that bilingual people were better mentally equipped to focus on tasks despite distractions. However, on the basis of these results, which are fairly similar in all groups, I can't say that native speakers of Croatian who are students of English or have a degree in English have Working Memory advantages or disadvantages when compared to native speakers of Croatian without a degree in English, or compared to native speakers of English.

92.5% of the participants thought that the text they were required to read was simple and clear. The text was simple enough even for unskilled readers, who also participated in this research. A more complicated text would have probably reveal bigger differences among the groups of participants.

A small drawback of this research is the fact that the participants did not read the text and fill out the survey in controlled conditions, but online, which may have influenced the results.

7. Conclusion

The purpose of this paper and the research that was carried out for it was to determine whether all readers make incorrect inferences besides the correct ones when reading and recalling a text. The results show that 100 percent of participants made incorrect inferences as part of constructing their mental models, regardless of their age, education, reading skills, or the ability to speak foreign languages perfectly. Therefore, the primary hypothesis that all readers make a number of incorrect inferences besides the correct ones when reading and recalling a text is confirmed.

The second purpose of the paper was to examine the differences in Working Memory capacity between 3 groups of participants - native speakers of English, native speakers of Croatian without a degree in the English language, and native speakers of Croatian who either have a degree in English or are students of English. The results show that in terms of Working Memory capacity, none of the groups has advantages or disadvantages compared to other groups.

In conclusion, mental models can affect the semantic memory of the reader. Constructing a mental model will make the reader more likely to remember parts of the text they find more important. All readers, even the most skilled ones, make incorrect inferences when constructing mental models. When it comes to Working Memory capacity, bilinguals do not have any advantages or disadvantages i.e. higher or lower Working Memory capacity when compared to monolinguals.

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Appendix 1

Questionnaires and texts used during the research

Read the text below carefully. You have 2 minutes.

How did the body of the murder victim come to be found in a locked room? Sherlock Holmes, the famous detective, was called in to investigate.

He examined the layout of the ground floor where the crime had taken place. The body had been found in the library. The only door into the library was from the hall, and it had been locked on the inside. The library was between the dining room and the sitting room. Several guests had come out of the dining room and gone into the sitting room, but nobody reported hearing voices from the library.

The body was discovered when a maid wanted to get into the library. The door had to be forced open as nobody had a spare key. There was a large fireplace in the library and the body was lying to the right of it. It was face downwards, with the legs towards the door and the left arm outstretched. Blood from the wound to the head had soaked into a valuable Persian rug. There had clearly been a violent struggle. A table had been overturned and a vase knocked on to the tiled floor. A lamp had been smashed.

Holmes pulled back the heavy curtains in front of one of the two windows in the room, and examined the window closely. His brain was working fast. Outside the window, a terrace ran alongside the house. It was still wet from the rain, and there were muddy footprints visible on it.

Pažljivo pročitajte tekst u nastavku. Imate 2 minute.

Kako je tijelo žrtve ubojstva pronađeno u zaključanoj sobi? Sherlock Holmes, poznati detektiv, pozvan je da istraži slučaj.

Proučio je plan prizemlja u kojem se zločin dogodio. Tijelo je pronađeno u knjižnici. Jedina vrata koja su vodila u knjižnicu nalazila su se u hodniku i bila su zaključana s unutarnje strane. Knjižnica se nalazila između blagovaonice i dnevnog boravka. Nekoliko gostiju izašlo je iz blagovaonice i ušlo u dnevni boravak, ali nitko nije prijavio da je čuo glasove iz knjižnice.

Tijelo je otkriveno kad je služavka htjela ući u knjižnicu. Vrata su morala biti nasilno otvorena jer nitko nije imao rezervni ključ. U knjižnici je bio veliki kamin, a tijelo je ležalo desno od njega. Bilo je okrenuto licem prema dolje, s nogama prema vratima, a lijeva ruka je bila ispružena. Krv iz rane na glavi natopila je vrijedan perzijski sag. Bilo je očito da je došlo do žestoke borbe. Stol je bio prevrnut, a vaza srušena na popločani pod. Svjetiljka je bila razbijena.

Holmes je povukao teške zavjese ispred jednog od dva prozora u sobi i pažljivo pregledao prozor. Mozak mu je brzo radio. Ispred prozora, uz kuću se pružala terasa. Bila je još mokra od kiše, i na njoj su se vidjeli blatni otisci stopala.

Mental models and inference in reading comprehension

Master's thesis survey

* Required

1. Tick which of the following pieces of information were supplied in the text. Do not look at the text. Remember: the issue is not whether these exact words were used, but whether this evidence was provided in the text. *

Check all that apply.

- [ ] 1 The sitting room was next to the library.
- [ ] 2 The library only had one door.
- [ ] 3 The key was on the inside of the library door.
- [ ] 4 There were people in the sitting room at the time of the murder.
- [ ] 5 Nobody had heard any noise from the library.
- [ ] 6 The library door had to be forced open.
- [ ] 7 There was a fireplace to the left of the body.
- [ ] 8 The victim was a man.
- [ ] 9 The victim was killed with blows to the head.
- [ ] 10 The fireplace was on the wall facing the door.
- [ ] 11 The body was face downwards.
- [ ] 12 The body was lying on a rug.
- [ ] 13 A vase had been broken.
- [ ] 14 There were two windows to the library.
- [ ] 15 The curtains in the library were drawn.
- [ ] 16 There was a terrace at the rear of the house.
- [ ] 17 It had rained on the night of the murder.

Please answer the following questions

Questionnaire

2. What is your age? *

3. What is your native language? *

4. Are you a native speaker of more than 1 language? *

Mark only one oval.

- Yes
- No

5. If yes, which?

6. Did you find the text simple and clear? *

Mark only one oval.

- Yes
- No

7. Do you think it would be easier for you to complete this task in your native language? *

Mark only one oval.

- Yes
- No
- English is my native language

8. Do you have a degree in English (bachelor's or master's)? *

Mark only one oval.

- ◯ Yes
- ◯ No

9. Do you fluently speak any languages other than your native language(s) and English? *

Mark only one oval.

- ◯ Yes
- ◯ No

10. If yes, how many?

11. Do you have a university degree in another language(s) or in linguistics? *

Mark only one oval.

- ◯ Yes
- ◯ No

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Mentalni modeli i inferencije tijekom čitanja

Istraživanje za diplomski rad

* Required

1. Označite kvačicom informacije koje su se pojavile u tekstu. Ne gledajte tekst. I zapamtite: nije bitno jesu li u tekstu korištene baš ove riječi, već jesu li u tekstu navedeni ovi dokazi. *

Check all that apply.

- [ ] 1 Dnevni boravak se nalazio kraj knjižnice.
- [ ] 2 Knjižnica je imala samo jedna vrata.
- [ ] 3 Ključ se nalazio s unutarnje strane vrata.
- [ ] 4 U dnevnom boravku je bilo ljudi u vrijeme ubojstva.
- [ ] 5 Nitko nije čuo buku iz knjižnice.
- [ ] 6 Vrata knjižnice morala su biti nasilno otvorena.
- [ ] 7 Kamin se nalazio lijevo od tijela.
- [ ] 8 Žrtva je bio muškarac.
- [ ] 9 Žrtva je ubijena udarcima u glavu.
- [ ] 10 Kamin je bio na zidu okrenutom prema vratima.
- [ ] 11 Tijelo je bilo okrenuto licem prema dolje.
- [ ] 12 Tijelo je ležalo na sagu.
- [ ] 13 Vaza je bila razbijena.
- [ ] 14 U knjižnici su bila dva prozora.
- [ ] 15 Zavjese u knjižnici bile su navučene.
- [ ] 16 Na stražnjoj strani kuće bila je terasa.
- [ ] 17 Kiša je padala u noći ubojstva.

Upitnik

Molim vas da odgovorite na sljedeća pitanja:

2. Koliko imate godina? *

3. Koji je vaš materinji jezik? *

4. Je li hrvatski vaš jedini materinji jezik? *

Mark only one oval.

- ◯ Da
- ◯ Ne

5. Ako nije, koji je drugi?

6. Smatrate li pročitani tekst jednostavnim i jasnim? *

Mark only one oval.

- ◯ Da
- ◯ Ne

7. Koliko stranih jezika tečno govorite? *

Mark only one oval.

- ◯ Nijedan
- ◯ Jedan
- ◯ Dva
- ◯ Tri
- ◯ Više od tri

8. Imate li zvanje prvostupnika ili magistra nekog stranog jezika ili lingvistike? *

Mark only one oval.

- Da
- Ne

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