

Open University of Cyprus

Faculty of Pure and Applied Sciences

Postgraduate (Master's) Programme of Study *Cognitive Systems*

Postgraduate (Master's) Dissertation



The Effect of Bilingualism on Executive Functioning and Second Language Reading Comprehension. A Comparison Study

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**Supervisor
Dr Maria
Sofologi**

May 2021

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The present Postgraduate (Master's) Dissertation was submitted in partial
fulfilment of the requirements for the postgraduate degree
in Cognitive Systems
Faculty of Pure and Applied Sciences
of the Open University of Cyprus.

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Summary

Bilingualism is a common phenomenon nowadays. More and more people are acquiring a second language as children and becoming bilinguals. Previous studies have shown that there is some bilingual advantage over monolinguals when it comes to an individual's cognitive abilities. Specifically, studies on both children and adults have shown that bilinguals have an enhanced executive function and working memory, cognitive abilities that people use throughout their lives. What is more, recent studies have shown that this bilingual advantage extends to bilingualism as well. Bilingualism refers to the mastering of two different varieties of the same language. Thus, the main goal of this master's dissertation is to examine whether bilingualism enhances the working memory and the executive function and thus, whether the bilingual advantage extends to bilingualism as well. What is more, this master's dissertation aims to also examine whether bilingualism affects reading comprehension in L2. For the purposes of the study, we administered a number of cognitive measures. In an attempt to evaluate the working memory, the Digit Span Forward and Backward, and a Verbal Fluency task were administered. For evaluating the executive function, we used a colour Stroop Test, while for the reading comprehension in L2 three passages from the International English Language Testing System (IELTS) standardized exams were extracted followed by five multiple-choice questions each. For the purposes of the study a total of 60 young adults were administered, specifically 30 Greek speaking monolinguals and 30 Cypriot-Greek bilinguals. Our results revealed that the bilingual group performed significantly better in all the cognitive tasks and specifically, in tasks that were more cognitively demanding. These findings suggest that the bilingual advantage exists and it further extends to bilingualism as well. As far as it concerns the three reading comprehension passages, the groups performed similarly and there was not any significant difference among the groups. This finding did not support our hypothesis that bilinguals will outperform monolinguals in the reading comprehension passages.

Περίληψη

Η διγλωσσία είναι ένα συνηθισμένο φαινόμενο στις μέρες μας. Όλο και περισσότεροι

άνθρωποι αποκτούν μια δεύτερη γλώσσα ως παιδιά και γίνονται δίγλωσσοι. Προηγούμενες έρευνες έχουν δείξει πως υπάρχει ένα διγλωσσικό πλεονέκτημα των δίγλωσσων πληθυσμών σε σύγκριση με τους μονόγλωσσους όπως προκύπτει από τις υψηλότερες επιδόσεις τους σε έργα αξιολόγησης των γνωστικών λειτουργιών. Ειδικότερα, έρευνες σε παιδιά διαφορετικών ηλικιών αλλά και σε ενήλικες διαπιστώνεται ότι οι δίγλωσσοι πληθυσμοί έχουν καλύτερες επιδόσεις σε δοκιμασίες μέτρησης των εκτελεστικών λειτουργιών και της εργαζόμενης μνήμης.

Επιπροσθέτως, σύγχρονες μελέτες έχουν δείξει ότι αυτό το διγλωσσικό πλεονέκτημα επεκτείνεται και στο δι-διαλεκτισμό. Ο όρος δι-διαλεκτισμός αναφέρεται στην απόκτηση δυο διαφορετικών διαλέκτων της ίδιας γλώσσας. Επομένως, απώτερος στόχος της παρούσης μεταπτυχιακής διατριβής είναι να μελετήσει την πιθανή επίδραση των φαινομένων της διγλωσσίας και του δι-διαλεκτισμού, τα οποία μπορεί να ενισχύσουν, αφενός την εργαζόμενη μνήμη, και αφετέρου τις εκτελεστικές λειτουργίες οδηγώντας σε υψηλότερες επιδόσεις. Συν τω χρόνω, ακόμη ένας στόχος της παρούσας μελέτης είναι η διερεύνηση της επίδρασης της διγλωσσίας και του δι-διαλεκτισμού σε έργα κατανόησης κειμένου στη δεύτερη ξένη γλώσσα. Για τις ανάγκες της έρευνας αξιολογήθηκε η Λεκτική Εργαζόμενη μνήμη με τη χορήγηση των υποκλιμάκων της Σειριακής Ανάκλησης Ψηφίων (Serial Digit Recall) και Αντίστροφης Ανάκλησης Ψηφίων (Backward Digit Recall) καθώς και τη Δοκιμασία της Λεκτικής Ευχέρειας (Verbal Fluency Test). Η αξιολόγηση των Εκτελεστικών λειτουργιών έγινε με τη δοκιμασία Stroop Test. Τέλος, η κατανόηση κειμένου έγινε με τη χορήγηση τριών κειμένων διαβαθμισμένης πολυπλοκότητας ως προς τη σύνταξη και τον αριθμό των λέξεων. Τα τρία κείμενα επιλέχθηκαν από τα εξεταστικά πρωτόκολλα των εξετάσεων πιστοποίησης International English Language Testing Systems (IELTS). Κάθε κείμενο αποτελούνταν από πέντε ερωτήσεις κατανόησης. Οι απαντήσεις ήταν με τη μορφή των πολλαπλών επιλογών.

Για τους σκοπούς της μεταπτυχιακής διατριβής Εξετάστηκαν συνολικά 60 ενήλικες (mean age 23.57), συγκεκριμένα 30 ομιλητές της Κοινής Ελληνικής και 30 ομιλητές της Κυπριακής Ελληνικής. Η ανάλυση των αποτελεσμάτων αποκαλύπτει

ότι οι συμμετέχοντες/ουσες της ομάδας των δι-διαλεκτικών είχαν υψηλότερες επιδόσεις σε όλες τις γνωστικές μετρήσεις που έγιναν. Τα ευρήματα αυτά υποδηλώνουν ότι το διγλωσσικό πλεονέκτημα επεκτείνεται και στον δι-διαλεκτισμό. Όσον αφορά τα κείμενα κατανόησης, οι δυο ομάδες είχαν παρόμοιες επιδόσεις, καθώς δεν προέκυψε στατιστικά σημαντική διαφοροποίηση μεταξύ των δυο ομάδων συμμετεχόντων/ουσών ωστόσο χωρίς καμία στατιστικά σημαντική διαφορά ανάμεσα τους. Το εύρημα αυτό δεν υποστηρίζει της υπόθεση ότι οι δι-διαλεκτικοί θα είχαν καλύτερες επιδόσεις στα κείμενα κατανόησης στην δεύτερη γλώσσα, σε σύγκριση με τους μονόγλωσσους.

Acknowledgments

Firstly, I would like to thank my supervisor Dr Maria Sofologi, for helping me shape and implement my research ideas, and for guiding me throughout this process.

What is more, I would also like to thank my parents for always being there supporting me either financially or emotionally. Also, I'd like to thank my family and friends, for being there in every step of this process. I couldn't miss mentioning my partner who has been next to me during the whole journey, and for helping me find many of the participants.

Finally, I would like to thank everyone who was by my side throughout this process, and of course the participants of this study who made some time to take part, despite their own responsibilities.

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Chapter 1

Introduction

A plethora of studies have suggested that there is a bilingual advantage seems to be present not only in bilingual population but in bilectal population as well. Most of the previous studies have focused on examining the cognitive abilities of bilingual and bilectal children compared to their monolingual peers. This master's dissertation aims to add on the limited body of studies who have examined adult bilectal population. Specifically, the master's dissertation will examine the working memory and the executive function of monolingual Greek-speaking and bilingual Cypriot-Greek young adults. Cypriot Greek (CG) is a variation of Standard Modern Greek (STM), and it is acquired and used for everyday communication, while STM is learned at school and it is used in reading, writing, and formal situations (Kyriakou & Spanoudis, 2020).

Previous studies on children (Kyriakou, Grohmann, Kambanaros, & Katsos, 2016) and in young adults (Kyriakou et al.,2020) have shown that bilectals are benefited from the bilingual advantage. Therefore, the present master's dissertation aims to replicate those results and to further examine whether this bilectal advantage affects reading comprehension in L2 English. We expect that bilectals will perform better in working memory and executive function task when compared to monolinguals. If bilectals will perform better in those tasks, we expect that they will also perform better in the reading comprehension tasks since working memory and executive functions have been closely aligned with successful L2 reading comprehension.

Under the aegis of the above mention research findings the present master's dissertation attempts to investigate the significant relationship between working memory and executive functions as well as their combined impact on the

performance of bilingual populations. More specifically, according to the first research hypothesis, bilingual young adults are expected to achieve a better performance on working memory tasks when compared to monolingual adults of the same age (Hypothesis 1). The relationship between the phonological working memory and the second or foreign language is confirmed and supported by a number of research studies (Gathercole, Briscoe, Thorn & Tiffany, 2008:13). Researchers emphasize on the fact that verbal working memory capacity is related to competence when acquiring a foreign language. Over time, working memory has been found to affect the extent to which stable phonological representations are created in long-term memory (Gathercole & Baddeley, 1990:10).

According to the second hypothesis, it is expected that bilingual young adults will perform better on inhibition tasks than monolingual participants of the same age (Hypothesis 2). Luk, & Bialystok, (2013) suggested that inhibition may be what links working memory and language learning. Furthermore, cognitive flexibility enables individuals to shift between different cognitive processing styles, thereby facilitates decision making, especially in environments characterized by high complexity like language (Guzman-Velez & Tranel, 2015:20).

As for the third hypothesis, it is expected that bilinguals will also perform better in the reading comprehension of the L2 reading passages (Hypothesis 3). A series of studies revealed that cognitive shifting and inhibitory control has a significant direct effect on reading comprehension (Spencer and Cutting 2021: 50).

Chapter 2

Literature Review

2.1 Reading comprehension

Reading texts has been always a way of acquiring knowledge. People had to learn how to read in order to be able to study, and educate themselves. Nowadays, reading is a main source of information whether it is for daily or academic purposes. People read newspapers, recipes, or even fun facts about the world. Students, from early on, learn how to read and throughout school years and they are asked to learn information based on books. College and university students are exposed to a massive number of written sources to gain knowledge and learn how to evaluate what is written and thus, reading comprehension has a major role in their studies. Based on the above, it is of vital importance to study reading comprehension in order to understand its nature but also the processes that take place, as well as the factors that contribute to a successful reading comprehension, while reading is what we use to acquire knowledge about the world around us (Yang 2016: 588).

To start with, in attempt to define reading ability is essential to underline the fact that reading is a learned ability and not an ability that is acquired from birth. Reading comprehension has been an issue concerning the research community for many decades. Researchers have given many definitions of reading comprehension with the most common definition being that reading comprehension involves “the construction of a coherent mental representation of the text in a reader’s memory”

(Kendeou, Muis, & Fulton 2011: 365). What is more, reading comprehension can be seen as a multi-faced process that involves further cognitive and linguistic abilities. Such cognitive and linguistic abilities require the readers to decode the meaning, to activate their background knowledge, to identify the relations between elements in the text, and to create mental models and memory representations (Carreiras & Clifton: 2004; Kintsch: 1988; O'Brien, Cook, & Gueraud: 2010; van den Broek: 2010; as referred by Ritchey 2011: 280). Also, cognitive functions like memory, attention and executive functions play a role for the process.

In addition to this, reading comprehension is characterized not only by its complexity but also it is characterized by its uniqueness (Rapp & van den Broek 2005: 276; Kendeou, McMaster & Christ 2016: 63). Humans seem to be the only one who have the ability to read and to decode words and sentences into meaning and using this decoded information to gain knowledge.

Reading comprehension has a significant role in the reading process and it constitutes a prerequisite to construct knowledge (Sofologi, Efstratopoulou, Kamari, Bonti, & Katsiana: 2020: 39). For a successful reading comprehension to occur readers should continuously evaluate and regulate their understanding (Zabrocky & Commander 1993: 442; Zabrocky & Moore 1999: 692) and actively reconstruct a "memory representation" based on their prior knowledge (Kendeou & van den Broek 2005). Also, it is of great importance for a reader to produce new informational schemas from the already existing data and to fill any missing information in order to understand the meaning of the text and build on it (Sofologi et al. 2020: 41). The final product of the reading comprehension is the mental representation of the text which is considered an off-line process, while the actual process of construction occurs simultaneously with reading and it is an on-line process (Kendeou, Muis & Fulton 2011: 365).

Throughout the years different theoretical approaches concerning reading comprehension processing have been proposed. For example, three types of the models are the bottom-up, the top-down and the integrative model. The bottom-up processes highlight the importance of lower-level skills such as decoding of words,

so that the reader can extract the meaning from the text (Floyd, Meisinger, Gregg, & Keith 2012: 725; Davoudi & Moghadam 2015: 174; Yang 2016: 586). Top-down processes emphasize the need of background knowledge in order for the reader to be able to carry out successfully the task of reading (Floyd et al. 2012: 725). Finally, the integrative approach towards reading suggests that there is an interaction between the lower-level and higher-level skills, meaning that readers simultaneously decode the texts and combines it with their previous knowledge (Floyd et al. 2012: 726).

The literature review revealed that one influential model of reading is the simple view of reading. The simple view of reading (SVR; Gough & Tunmer 1986), is a bottom-up model which suggests that the word recognition and the linguistic comprehension constitute the reading processes, and thus word fluency is considered as an important contributor to reading comprehension (Floyd et al. 2012: 740; Mellard & Fall 2012: 21; Hannon 2012: 147). However, despite the fact that there are studies that support SVR, it should be also notes that this model fails to explain the relationship and the coordination of both top-down and bottom-up processes. Floyd et al. (2012: 726) also mention that the integrative models were developed as an answer for the inadequacy of the strictly bottom-up and top-down models. What is more, Sabatini, Sawaki, Shore, & Scarborough (2010: 123) examined the interrelationships among the simple view components. Specifically, the participants were adults who sought literacy assistance. Their experiment consisted of reading and language skills tasks. The results of this study failed to lend any support to the SVR.

Additionally, as the literature review suggests, of the most influential models on reading comprehension has been the situational model by Kintsch (1994,1998; as cited by Sofologi et al. 2020: 39). During the 1970s and the 1980s Kintsch had identified three levels of representation that take place during text comprehension. The first level, known as surface level, is where the reader identifies the structural characteristics of the units consisting the sentences and identifies and codes the linguistic relations between them. At the second level, the reader accomplishes the syntactic and the semantic representation of the information of the given text. At

the last level, also known as situational level, a deeper understanding is accomplished by an internal acquisition of the meaning. At that stage, the reader links the already existing information with the information provided by the text in order to create a situational model.

Moreover, Rapp and van den Broek (2005: 277), proposed an integrating view of reading with the dynamic text comprehension. Based on the dynamic text comprehension the authors proposed the Landscape model of reading. Dynamic text comprehension attempts to extend the research in various ways. First, it can integrate multiple factors of reading such as text properties, characteristic of memory representation, individual differences of the reader, etc., and their interactions in a single framework (Rapp & van den Broek 2005: 277). Second, it attempts to explain the activated concepts and their dynamic fluctuations during moment-by-moment comprehension of the entire texts. Third, the processes and products of comprehension are taken into consideration; fourth, in order to examine these factors computational simulation of behavioural data are involved. Finally, in some cases it allows for competing hypotheses to integrate. (Rapp & van den Broek 2005: 278).

Based on landscape model, the text is processed by the reader through cycles that correspond to a clause or a sentence. From cycle to cycle, the activated concept fluctuations are seen as a function of four sources: “(a) text input in the current cycle, (b) residual information from the preceding cycle, (c) the memory representation constructed for the text read so far, and (d) the reader’s prior knowledge” (Rapp & van den Broek, 2005: 277). DLC theories, based on Rapp and van den Broek (2005: 278) provide framework that considers multiple factors during reading.

What is more, Kendeou, Papadopoulou and Spanoudis (2015: 120) proposed that reading comprehension can be explained by the PASS theory. PASS theory (Planning, Attention, Simultaneous, and Successive; Naglieri & Das 1997) is a cognitive processes theory (as referred by Kendeou et al. 2015: 120). They proposed that PASS theory’s relevance of reading increases as the demands of the

reading task increases as well (Kendeou et al., 2015: 122). Specifically, the lower-level reading skills (e.g orthographic and phonological processing) are related to Successive and Simultaneous processing while higher-level reading skills (e.g. inferences) are related to Planning and Attention (Kendeou et al. 2015: 122,123).

Another model also related to reading comprehension was proposed by Kinnunen and Vauras (1995). They propose that the construction of the meaning is carried out in three different levels. In the first level the reader receives the linguistic stimulus, either visually or acoustically. During this process, the reader tries to construct the meaning of the words and the simple sentences in order to create an organized cognitive load. In the second level the reader tries to comprehend the meaning of all the utterances of the text with the main goal to be the construction the whole mental representation of the reading material. It is a complex process which demands the linking of all the words and utterances of a text in order to clarify the meaning of it. Finally, in the third level, the reader constructs a mental representation of the overall construction of the texts, achieving a deeper comprehension.

Moreover, Smith (2006), highlights the dynamic nature of comprehension. More specifically, he supports that the access to the text meaning can be direct or indirect. The indirect process concerns the decoding of the linguistic units in order to recognize the words and later on giving a meaning to them. It should be also noted that, during the process of the indirect recognition of the meaning for the comprehension, the cognitive load can be increased due to the decoding of a large number of visual information. The direct process is linked to the direct access to the word meaning for a deeper comprehension which will occur with the link of the overall utterances meaning. The author also mentions that the direct recognition of the mental content of a text may facilitate comprehension. Finally, the author also supports that the direct recognition is linked with high reading speed of proficient readers, which as a result lead to the extraction of a text meaning.

Finally, based on Oakhill and Cain (2004), emphasize the role of the construction of relational representation of a text to occur in reading comprehension. That means

that the reader should create a mental model or a model that refers to a specific situation mentioned in the text. Based on this, what leads to the comprehension of a text, is the construction of a combined and coherent representation of its content. Within this framework, the construction of semantic maps can be an effective organizational cognitive strategy that can enhance people with low academic performance to create meaningful semantic link for the context of a text, and as a result to improve the comprehension of their reading material (as noted by Sofologi 2018: 35)

To sum up, the above models illustrate that when trying to explain the reading comprehension processes it is of vital importance to understand the processes that underlie it and how these can be explained. Also, despite their differences these models, one could argue that these models highlight the interactive nature of reading comprehension. A question that arises is what factors are considered predictive or of a great importance when examining reading comprehension.

2.1.1 Factors affecting reading comprehension

As it is also mentioned above, reading comprehension is a complex process that involves many cognitive abilities and processing either on a lower- or higher-level. Executive functions, working memory, attention, and level of language proficiency are some of the factors that shape the cognitive profile of a reader which consequently affects the reading comprehension process.

Executive functions have been a central factor that affects reading and thus it is widely examined. Based on Chan, Shum, Touloupoulou and Chen (2008: 201) executive functions refer to the set of abilities that are used in order to achieve a goal (as referred by Georgiou & Das 2016: 118). What is more, Georgiou and Das (2016: 120), examined the effects of executive function in reading comprehension. Generally, it is considered to be a strong predictor for academic achievement. Executive functions include inhibition, shifting and working memory (Georgiou et al. 2016: 119). Each of these functions has its own contribution and necessity for reading comprehension. Working memory is important because the readers can

hold information without having to reread the text while it is also important to shift their attention to the relevant and important information. Also, it is of great importance for the readers to be able to engage to comprehension monitoring such as “identifying the main idea and knowing when to reread or skim through a passage is critical” (Georgiou et al., 2016: 125). Most of the research has been focused on children and students at elementary and high school students. Georgiou and Das’ study (2016: 120) examined undergraduate students on reading comprehension and the effects of executive functions. Their results revealed that shifting has a significant direct effect on reading comprehension while inhibition did not exert any effects on comprehension.

Nouwens, Groen, Kleemans and Verhoeven (2021: 171,172) mention that due to the fact that our cognitive system has limited capacity in terms of processing, when reading occurs the processes that are involved should compete in order to be a part of the processes that take place in the cognitive system. Executive functions have been suggested to facilitate reading comprehension. This happens by collaborating and controlling integrating and retrieving information from the mental lexicon using strategies and at the same time engage the multiple reading processes that are involved (Nouwens et al. 2021: 171). Miyake, Friedman, Witzki, Koverter, and Wager (2000) identified three core executive functions that are involved in adults namely, updating and monitoring of working memory processes, inhibition, and cognitive flexibility (as referred by Nouwens et al. 2021: 171).

Follmer (2018: 44) reported that executive function has a moderate positive association with reading comprehension and that variance in comprehension can be explained by this. They further suggested that executive function allows readers to develop and revise plans for the reading text and combine and integrate information from prior knowledge, while they acknowledge different components of the text. This results to the accurate development of a mental representation of the text by choosing their strategy in accordance with the needs of the text. Titz and Karback (2014: 854) reported that training in executive functions and working memory can enhance the academic performance of the participants when it comes to language and reading. What is more, Spencer and Cutting (2021: 50) examined the associations between executive function, decoding and reading comprehension

and their results revealed direct and indirect effects on reading comprehension via decoding by executive functions.

There is a growing body of literature examining the processes and the factors that affect and also can predict the reading comprehension process and performance. Working memory is a component that has been suggested to affect the reading process and therefore the reading comprehension. Working memory is of a limited capacity and it specifically holds information that are necessary for the task that the individual carries out (Titz & Karbach 2014: 853). Therefore, it is necessary for the reader to be able to hold information from the text in order to associate that information with information stored in the long-term memory. A meta-analysis by Daneman and Meikle (1996: 430) revealed a significant role of working memory in reading comprehension. Alloway and Gregory (2013: 52) investigated the predictive roles of working memory and IQ in adults ranging from 17 to 58 years old. Their results revealed that verbal comprehension and working memory largely contribute to comprehension performance, concluding that the combination of crystallized intelligence and working memory are significant predictors for literacy skills in adults. What is more, research in older adults revealed that working memory training can benefit older adults in their language comprehension (Carretti, Borella, Zavagnin, & de Beni: 2013, 545).

Arrington, Kulesz, Francis, Fletcher, and Barnes (2014: 329) examined the relationship between three functions of attentional control namely, response inhibition, sustained attention and cognitive inhibition, as well as their relationship with working memory and reading, in adolescent students. Their findings suggested several things. There was a significant direct effect of attentional control, cognitive inhibition and sustained attention to reading comprehension, and a significant direct effect of attentional control to decoding as well. An indication was that apart from working memory, cognitive inhibition is also a distinct executive function, as proposed by Miyake et al. (2000) and Palladino & Ferrari (2013), and it has a unique role when it comes to contributing to reading comprehension (Henderson, Snowling, & Clark 2013; Pimperton & Nation 2010; as referred by Arrington et al. 2014: 340).

A number of studies also highlighted the importance of the vocabulary when examining reading comprehension. Hogan, Bridges, Justice, and Cain (2011: 1) provided an overview concerning the higher-level language skills and the improvement of reading comprehension. They reported that there is evidence that it is critical for good comprehension for a reader to have higher level language skills such as inferencing and comprehension monitoring. Also, they further noted that vocabulary knowledge is also a prerequisite in order to understand the sentences and on a later stage to extract the meaning using higher level skills as noted above (Hogan et al. 2011: 3). Landi (2010: 712,713) on the other hand found that there is a partial dissociation between higher level reading skills and lower-level reading skills in adults. The results also provided evidence for the hypothesis that “word knowledge is critical for good comprehension” (Landi 2010: 712). Vocabulary was a unique predictor of comprehension and it had the highest correlation with comprehension as well. When it comes to decoding, the author suggested that the results support the notion that decoding it is not a predictor for adults’ reading comprehension, and also it is not a limiting factor for either adults’ or children’s reading comprehension.

In addition to vocabulary, it is also suggested that poor vocabulary can attribute to the failure of retrieving cues in the text that activate prior knowledge (van Dyke, Johns, & Kukona 2014: 399). Sabatini, Sawaki, Shore, and Scarborough (2010: 133) found that word recognition and language comprehension are closely related with low-literate adults’ reading comprehension. Mellard and Fall (2012: 21) provided further support to this view since their findings revealed that lower-ability readers mostly rely on word recognition, while mid-level and better readers did not only rely on word recognition but they also rely on memory and language for comprehension as well.

Moreover, Kendeou, McMaster and Christ (2016: 63,64) identified inferences as the cornerstone of reading comprehension and knowledge as a necessary source for reading comprehension. Inferences refers to the information that is used to fill any gaps of the written texts. This information is either retrieved from memory or

generated during reading (Elbro & Buch-Iversen 2013; as cited by Kendeou et al. 2016: 63). Based on Parfetti and Stafura (2014), there are three sources of knowledge namely, the linguistic knowledge, the orthographic knowledge, and the general knowledge (as cited by Kendeou et al. 2016: 65). Also, Kendeou, van den Broek, Helder, and Karlsson (2014: 12) mention that it is of great possibility of a reader who is weak in making inferences to fail comprehend the content of even simple texts. In order for someone to be able to build inferences he/she has to have background knowledge (Kendeou et al. 2014: 12).

Kendeou and van den Broek (2005: 235) examined the online and offline effects of readers' misconceptions on the comprehension of scientific texts. Their results demonstrated that readers with and without misconception do not differ in terms of the types of the processes they used, but rather they differ in terms of the content of those processes. Also, in their research readers' misconceptions seemed to interfere on their memory resulting to quantitative and qualitative problems. Moreover, their findings were consistent with previous researches on knowledge incorporation versus compartmentalization. Incorporation refers to the integration of new information from the text with previous knowledge of the reader whereas, compartmentalization refers to the isolation of the information of the text from the previous knowledge (Potts & Peterson 1985; Potts, Peterson, St John, & Kirson 1990; Potts, St. John & Kirson 1989; as cited by Kendeou & van den Broek 2005: 235,236). Finally, their results provided evidence that reader's misconceptions and the differences in working memory capacity have an effect on science text comprehension.

What is more, Kendeou, Muis and Fulton (2011: 367) examined the influence of epistemic beliefs and text structure on the conceptual change processes during reading comprehension on undergraduate students. There were two experiments an on-line task and an off-line and the participants were divided into readers with less or more sophisticated beliefs. The on-line task results provided evidence that both epistemic beliefs and text structure have interactive affects during reading. Also, the current results support the influence of memory-based and constructionist processes to reading comprehension as proposed by van den Broek (2005;

Kendeou, Muis & Fulton 2011: 372). As far as it concerns the off-line task, there were not any differences between the two groups of participants; less and more sophisticated readers. The researchers concluded that their overall findings provide evidence on how epistemic beliefs and text structure play a role on the conceptual change processes during reading comprehension.

Another component that is known as having effect on reading comprehension is metacognition and specifically metacomprehension. Metacomprehension refers to the ability to evaluate the learning and the comprehension of a text (Serra & Dunlosky 2010: 698). Metacomprehension is also defines as the reader's awareness of the factors affecting comprehension and comprehension monitoring as well as the person's ability to control cognitive actions during reading (Thiede, Kirk, & Woods 2012; as cited by Sofologi et al. 2020). Additionally, Zimmerman (2008) mentioned that metacognition influences the achievement of reading due to the fact that readers must set goals and accordingly choose which strategy to use, and at the same time monitoring the effectiveness of their reading (as referred by Afflerbach, Cho, Kim, Crassas, & Doyle 2013: 446). The accuracy of monitoring of reading comprehension is very important since it can differentiate the performance through the mechanism of self-regulation. Moreover, Afflerbach et al. (2013: 447) mention that metacognition, epistemic beliefs, self-efficacy, and motivation and engagements are involved in reading comprehension.

Serra and Dunlosky (2010: 700) examined whether readers incorporate their beliefs when it comes to the effects of text format. Their experiments contained multimedia text format (e.g. graphs, diagrams, etc.). The majority of their participants believed that the multimedia format will facilitate their learning. Their findings were consistent with the heuristic-based accounts of metacomprehension judgements, and thus supporting that in order to construct their assessments of learning text materials, readers rely on heuristic, but also their findings showed that the participants were biased by their judgement of the multimedia format even though when it did not boost their learning. Zabucky and Moore (2010), examined the influence of text genre on older and younger adults' monitoring of understanding and recall. Their findings provided further evidence

that comprehension of narrative text is faster and easier when compared to the comprehension of expository text, and also replicated the results by Petros et al. (1989) and Tun (1989) that the recall was better for narrative than expository texts (Zabrocky & Moore 2010).

Based on the above, despite the importance of component like text genre and executive functions, metacomprehension plays an essential role to the process of reading comprehension. Strategies that the readers use to monitor and evaluate their comprehension are crucial and therefore several studies have been carried out to examine the role of comprehension strategies to reading comprehension. Comprehension strategies are very important especially for readers since they can help them deal with understanding of texts in a more efficient way.

Moore, Zabrocky and Commander (1997: 469) examined the metacomprehension and comprehension performance in younger and older adults. Their results were promising for self-assessments of metacomprehension to be important predictors of performance.

Also, the results indicated that younger adults “report greater use of selected metacognitive activities” and that selected metacognitive abilities are predictors for comprehension and more general verbal ability (Moore, Zabrocky, & Commander 1997: 472). There were also indications that more highly verbal adults are using strategies to resolve comprehension failures than the less highly verbal adults. The overall findings of their study supported that self-reported regulation is an important predictor for comprehension performance. Also, Rawson and Dunlosky (2007: 576) proposed that self-testing can be effective for improving students’ self-regulated learning.

Furthermore, there is evidence that a very effective reading-comprehension strategy is knowledge mapping (Amer 1994: 43). Knowledge-mapping includes reading the text and reorganizing the main themes, selecting the most important concept and then reread the text and not any other key concepts. Readers then should put the concepts in a hierarchical way and as a final step they should show the relationships between the concept. (Amer, 1994: 42). Zabrocky and

Commander (1993: 445) examined good and poor comprehenders in terms of the regulation strategies they use during reading. Their findings showed that good comprehenders are characterized by their ability to be more selective and focus their rereading when the comprehension fails as opposed to poor comprehenders who seem to reread indiscriminately. Ahmadi, Ismail and Abdullah (2013: 241, 242), mention that the use of metacognitive reading strategy by readers lead them to a more successful comprehension.

To sum up the above, reading comprehension is characterized by its complexity in terms of the factors that are involved in the process. Despite the characteristics of a text and the cognitive functions that are involve, the literature suggests that metacognition or metacomprehension abilities have a crucial role for successful reading comprehension.

2.1.2 Experimental designs of reading comprehension

Throughout the decades many experimental designs and methodologies have been proposed to examine reading comprehension in adults. The literature review reveals that one of the most commonly-used method for reading comprehension an its strategies used, is the think-aloud method (e.g. Kendeou & van den Broek 2005, 2007; Willey, Griffin, Jaeger, Jarosz, Cushen, & Thiede 2016: 397; Davis, Huang, & Yi 2017: 231; Kendeou, Muis & Fulton 2011: 369). Specifically, in this case participants are required to read a passage, and while reading they have to reflect to each sentence or paragraph. Usually, after the reading of the passage, participants are asked to provide as much information they can recall for the tests.

Additionally, another commonly used method is providing the participants with a passage and after their reading participants are asked to answer reading comprehension questions. These reading comprehension questions include multiple choice questions (e.g. Hannon 2012: 131; Willey et al. 2016; Bojovic 2010: 2; Georgiou & Das 2016: 122; Landi 2010: 710), verification tasks – True-False questions (e.g. Ritchey 2011: 284; Bojovic 2010: 2; Moore, Zabrocky, & Commander, 1997: 469; van Dyke, Johns, Kukona 2014: 377; Rawson & Dunlosky, 2007: 565), cloze tasks (e.g. Bojovic 2010: 2; Mellard & Fall 2013: 14) and short answer

questions (e.g. Serra & Dunlosky 2010: 701). Several studies examined reading comprehension by asking the participants to generate their own questions on the passage they have read (e.g. Weinstein, McDermott, Roediger 2010) or to provide a summary of the main ideas of the text (e.g. Ritchey 2011: 284).

2.2 Bilingualism Spectrum

Nowadays, more and more people are speaking more than two languages and many of those people were exposed to a second languages in their early years of life. Those who have acquired two different languages from birth are considered to be simultaneous bilinguals (Slabakova 2016). However, bilingualism is not limited to acquiring a second language since birth, but children who are exposed to a second language later on can be considered bilinguals as well. Despite age being an important indicator for bilingualism, other factors such as language exposure and language use play an important role (Slabakova 2016). Bilingualism can be also described as the dual language use, since those individuals switch to the suitable language according the social context. For example, a bilingual might use the first language at home, while the second language being necessary for school, work, or any other social context.

Bilingual individuals are required to control the two simultaneous activated languages, and specifically the inhibition of lexico-semantic competitors of the non-intendent language (Green 1998; as referred by Barbu, Orban, Gillet, and Poncet 2018: 116). Therefore, researches suggested that the management of two or more languages posits demands on the cognitive control system of an individual especially in the case where the individual switches between language and suppresses the one it is not used (Kroll, Bobb, Misra, and Guo,2008; as referred by Sorman, Hansson, & Ljungberg, 2019). Moreover, Bialystok (2015) mentioned that bilinguals outperform their monolingual peers when the “tasks are effortful and include perceptually conflicting information” (Bialystok 2015: 118).

During the 20th century, there was a common misconception about bilingual children that they fall behind their monolingual peers, however that is not the case.

Diamond (2010) mentioned that bilingualism comes with many advantages (as referred by Antoniou 2019: 396). There is also the view of a bilingual advantage on executive functions. Executive functions, based on the model proposed by Miyake (2000) consists of inhibition, updating (working memory), and switching. Several studies have suggested that these functions are enhanced in bilinguals when compared to monolinguals (e.g. Antoniou, Grohmann, Kambanaros, & Katsos 2016; Bialystok 2007 ; Barbu, Orban, Gillet, & Poncelet 2018: 122). Despite the fact that there is a growing body of evidence suggesting that there is a bilingual advantage in executive function, several studies fail to replicate this finding. For example, Kousaie, Sheppard, Lemieux, Monetta and Taler (2014: 9) examined the differences between younger and older bilinguals in terms of executive functions and their results did not reveal any advantage. It should be also mentioned here that the bilingual advantage is more evident in children and older bilinguals than in young bilinguals. Specifically, there is evidence that bilingualism protects lifelong bilinguals from decline in executive control (Bialystok 2010: 564).

Barbu, Orban, and Poncelet (2018: 118) examined the effect of oral language switching frequency on the performance of proficient bilinguals in response inhibition, cognitive flexibility and alerting skills tasks, which are considered to cover a range of executive subcomponents. The groups were divided in terms of the language-switching frequency, specifically, the HFLS group which switched language orally at least 20 times per day, and the LFLS group which switch language orally maximum 6 times per day. Their results revealed that the HFLS group responded more quickly on the cognitive flexibility task when compared to the LFLS group. The authors concluded that, oral language switching frequency can be considered as an underlying factor that enhances the cognitive flexibility of proficient bilinguals. They further suggest that bilingualism per se is not the reason for the “bilingual advantage” in attentional and executive skills but rather the reason is the language-switching frequency. Barbu, Gillet, and Poncelet (2020: 8) replicated the results of this study. The authors here proposed that any bilingual advantages might be easier to be traced at a neural level using other methods such as brain imaging measures such as fMRI, EEG, and MEG.

Zeng, Kalashnikova, and Antoniou (2019) examined bilinguals and monolinguals which were further separated into three groups in terms of their age, specifically, school-aged children, young adults, and older adults. Their aim was to examine the effects of bilingualism across the life span, specifically on the performance of executive functioning, linguistic processing abilities and individual linguistic competence. In order to examine the receptive and the expressive vocabulary, they administered the Peabody Picture Vocabulary Test IV (PPVT) and the Expressive Vocabulary Test II (EVT). Also, a verbal fluency task (VFT) was also administered in which participants had 60 seconds for each condition; the letter VFT where participants had to produce words starting with the letter 'f' (proper names were excluded), and the category VFT where participants had to produce as many animals' names as they could. For the executive functions, a Simon Task was administered. Their results revealed that there was a bilingual advantage only for children and older adults. The authors argued that these findings support the claim such effects are more pronounced at times when there are developmental changes in executive functioning skills (Zeng, Kalashnikova, & Antoniou 2019).

Finally, Zirnstein, van Hell, and Kroll (2019) examined the cognitive control and language ability contributes to online reading comprehension in older adults. For the purposes of the study, a fluency task, an Operation span task, and the distractor version of the AX Continuous Performance task were used. The findings revealed that older adults are able to engage in predicting during online comprehension which is considered to be a highly resource-demanding task. Specifically, the authors mention that the older adult participants showed evidence of recruitment of executive control during comprehension in a different way than their monolingual peers.

When it comes to the dual language usage there is another case except for bilingualism. Bidialectalism or bilectalism is the usage of two varieties of the same language. Bilectalism can be also explained as an extreme case of language similarity (Oschwald, Schattin, von Bastian, & Souza 2018: 2). Several studies have examined bilectalism and its effects on executive functions. For example, Antoniou, Grohmann, Kambanaros, and Katsos (2016: 10) examined the effect of childhood

bilectalism and multilingualism on executive function. The results suggested that bilectalism and multilingualism can lead to “qualitatively similar” advantage in executive control ability (Antoniou et al. 2016: 28). It is worth mentioning that the study included Standard Modern Greek (SMG) and Cypriot Greek (CG) dialect of SMG and based on Lewis et al. (2014) the two varieties have a lexical similarity of 84-92% (as referred by Antoniou & Spanoudis 2020). Antoniou and Spanoudis (2020) examined monolingual, bilectal, and multilingual young adults, in terms of their executive functions. The results revealed that the multilingual and bilectal group perform significantly better in the executive control tasks than the monolingual group.

Oschwald, Schattin, von Bastian, and Souza (2018: 3), explored the role of language similarity as a link between linguistic ability and executive control, focusing on the case of bilingualism and bilectalism. The participants were young adults. For the inhibition a flanker task and a Simon task were used, for shifting and mixing a figural and numerical switching tasks were used. What is more, for monitoring a digit task and a square task were administered where the participants had to sustain their attention to a stream of inputs in order to detect patterns and relations. For working memory, a figural and numerical version of the list-switching paradigm was assessed and for reasoning they administered the short-computerized version of Raven’s Advanced Progressive Matrices. The authors concluded that the similarity of the languages spoken by bilectals and bilinguals seem to affect the linguistic processing but there aren’t any substantial evidence supporting increased executive function benefits.

Hsu (2021) examine the cognitive control in older Minnan-Mandarin and Hakka-Mandarin bilectal adults. Specifically, nonverbal and verbal cognitive tasks were administered including the Simon, Stroop, flanker and spatial n-tasks. Bilectals, when compared to monolinguals, performed better on the verbal and non-verbal Stroop color-word tasks and the verbal Stroop day-night task. What is more, a bilectal advantage was also found in tasks that involved attentional and inhibitory control. As a result, the authors suggest that the bilingual advantage does not only extend to bilingualism but in bilectalism as well.

As follows from the studies mentioned above, the bilingual advantage seems to exist and benefits the individuals with better cognitive abilities. Many studies have shown that bilinguals perform better on working memory and executive functions tasks when compared to monolinguals. What is more, recent studies revealed that this bilingual advantage is also present at people who acquire two dialects. More studies are needed in order to examine whether this bilingual advantage exists and to replicate the results showing that bilinguists are benefited from this advantage as well.

Bilingualism and bilinguism is a complex condition that it is hard to precisely explain and measure, due to the fact that many factors play a role in order for someone to be considered as bilingual or bilinguist. However, the literature suggests that people who acquire two languages or two varieties of the same language, benefit when it comes to cognitive functions. This advantage is more apparent to children and older adults, but it exists in younger adults as well. (Antoniou et al. 2020; Oswald et al. 2018: 17; Hsu 2021). It is of great importance to be able to explain and shed light to the bilingual and bilinguist advantage due to the fact that nowadays people are acquiring more than one language or dialect constantly. Finding an advantage of bilinguists over monolinguals can have some pedagogical implications as well, since in many cases, dialects are stigmatized and are not used in a classroom environment, and thus, by promoting the use of dialects in such contexts might be more beneficial for students as well.

2.2.1 Reading Comprehension in L2

As the world becomes a big neighbourhood, more and more people are speaking more than one language. Many of them acquire the second language later in their life and thus they cannot be considered as bilinguals. In many countries there are compulsory courses of the English language since it has been the dominant language for several years. Students, especially at the university level need to access original sources which most of the times if not all of the times, this literature is in English. Therefore, English as a second or as a foreign language can be considered as a prerequisite in a way for an academic success. But what strategies and which factors influence reading comprehension in second or foreign language?

Second language is used to refer to the language this is learned and spoken in the community. (Yang 2016: 587). In many cases second language is used to referred to the foreign language which is a language that is also learned but not spoken in the community (Yang 2016: 587). In this study, second language will be used to referred to the learned language that it is not spoken in the community. Second language learners, and therefore readers are people who have already acquire their first language and the mechanism that are involved. Consequently, an L2 reader has already acquired and learned the mechanisms and processing that is needed for reading comprehension,

To start with, Block (1986) mentioned that a characteristic of good readers is their ability to monitor their comprehension and be aware of the strategies they use, while Laufer and Sim (1985) mention that second language (L2) reading is a function of foreign language competence and the reading strategies used. Brantmeier (2005), proposed that L2 subject language (or background knowledge) is highly influential to L2 reading comprehension. Several studies have been carried out examining which factors are considered predictive in L2 reading. Block (1986) examined the strategies used in L2 reading but the sample was too small since it consisted of only 9 participants. The results of this study did not reveal any effect of background knowledge to the strategies used and the author proposed that there might be a difference in first language (L1) and L2 learning of reading.

One factor that affects L2 reading comprehension is background and vocabulary knowledge. Peter Tze-Ming Chou (2011), examined the effects on background knowledge and vocabulary knowledge in Taiwanese students of English reading comprehension ability. A total of 159 participants were examine and the results revealed that the vocabulary knowledge was significant in understanding the reading passage and this ability can increase the overall performance of reading comprehension. In addition to background knowledge, Shin, Dronjic, and Dark (2018) investigates the interaction of working memory (WM) and background knowledge in L2 reading comprehension, in 79 Korean EFL (English as a Foreign Language) students. High working memory capacity participants benefited more

from the background knowledge when compared to the low working memory capacity participants. This finding lend support from the rich-get-richer model which suggests that high working memory can enhance the positive effect of prior knowledge on cognitive performance. Zhang (2012) re-examined the importance of vocabulary and grammar knowledge in L2 reading comprehension of 190 EFL adult learners. Their results suggested that vocabulary is more strongly predictive than grammar when it comes to L2 reading comprehension. Also, it was suggested that background knowledge and metacognition play an important role in the reading comprehension.

In terms of other factors that affect L2 reading comprehension working memory has been also suggested to be a strong predictor. Joh and Plakans (2017) reported that the contribution of working memory to reading comprehension was a result of prior knowledge concluding that both factors are significant contributors for L2 reading comprehension. Alptekin and Ercetin (2011) also found that high memory span readers outperform low-span readers in inferential comprehension. Guo and Roehrig (2011) examine the contribution of L2 vocabulary knowledge, syntactic awareness and metacognitive awareness in L2 reading comprehension. The results revealed that language specific knowledge of L2 is a significant predictor for L2 reading comprehension and at the same time, reading strategies can compensate for lack of L2 language proficiency. Finally, Adams and Shahnazari-Dorcheh (2012), found a relationship between working memory and L2 reading ability, but working memory was predictive for beginners' reading ability while for high proficiency students language knowledge played an important role.

In addition to WM and executive functions, attentional control also plays a role in reading comprehension and especially in L2 reading comprehension. Grabe (2014) mentioned WM and executive control processing involve the ability to attend selectively to specific information and at a later point respond to this information. What is more, Grabe also mentioned that attention involves strategic reading when the reading requires learning.

What is more, Rai, Loschky, Harris, Peck, and Cook (2011), mentioned that while reading, goal-directed attentional system is used in order to retrieve information from the long-term memory in order to process this information for meaning. In addition to this Service, Maury, and Luotoniemi (2002) referred that due to the fact that a second or foreign language is less automatized than first language, its process will require more attention to process (as referred by Rai et al. 2011). Furthermore, Eysenck, Sandos, Derekshan, and Calvo (2007), proposed the Attentional Control Theory under which, a factor that can affect the attentional control is the stress (as referred by Rai et al. 2011). Specifically, they argued that stress poses an extra demand in working memory and as a result it reduces working memory capacity.

Other researchers examined the relationship and the contribution of L1 literacy to L2 reading comprehension. Specifically, Artieda (2017) found that first language and L1 spelling affected only beginners. Brantmeier (2005) found negative effects when providing the participants with the analogy passage in their first language.

Guo (2018) investigates the direct effects of metacognitive knowledge, L1 reading ability and L2 proficiency on L2 reading. Metacognitive knowledge revealed indirect effects on L2 reading via L1 reading ability and L2 proficiency. What is more, L2 proficiency is of great importance for the learners' strategies. Finally, Silawi et al. (2020) found that metacognitive monitoring is strongly linked to successful comprehension and they define monitoring ability as a domain-general skill.

Based on the above, L2 reading comprehension share some similar processes with L1 reading comprehension. However, due to the fact that L2 is learned at a later stage, there are several more factors that affect the reading process. Vocabulary and grammar are very important when it comes to reading, but it is also important for someone to be able to compensate when a difficulty or an unknown word is found. What is more, executive function and working memory seem to play a major role in L1 and in L2 reading comprehension. It is of great importance to be able to focus and pay attention to the important points in a text, as well as being able to make inferences based on your prior knowledge. Finally, it is also essential for an

individual to be able to self-monitor the reading comprehension process in order to be successful in the process.

CHAPTER 3

Experiment

3.1 Methodology

3.1.1 Participants and settings

For the purposes of the present reach study, a total of 60 young adults were selected. More specifically, the first group of monolingual participants consisted of 16 females aged 19-29 years (mean age 23.20, SD 2.80 years) and 14 males of the same age mean age 23.20, SD 2.80 years). The experimental group consisted of 30 bilingual speakers of Cypriot Greek (CG) and SMG, 14 females aged 19-29 years (mean age 23.2, SD 2.80 years) and 16 males (mean age 23.2, SD 2.80 years). The monolingual young adults were all undergraduate psychology students while the bilingual adults were undergraduate and postgraduate students from mixed academic background such as political science, education science, psychology, engineering, history and chemistry. What is more, the participants were matched in age and gender. The participants of both groups came from different socioeconomic status.

Table 1. Mean age and standard deviations for both groups of participants

	Gender		Age	
	Female	Male	Mean	SD
Monolingual	16	14	23.20	2.809
Bilingual	14	16	23.20	2.809

Notes: SD= Standard Deviation

3.1.2 Procedure

The examination of the participants was individual and it took place according to the preferences of the participants. The evaluation was two-phased. In the first phase the cognitive measures were carried out, while in the second phase the reading comprehension passages were given to the participants. The study consisted of two phases so that we could avoid any cognitive load for the participants and to minimize any other effects to the reading comprehension process. Due to the restrictions of COVID-19 most of the participants were examined in distance using online platforms or social media. The participants in this master's dissertation had no official diagnosis of any learning difficulties or mental disabilities (based on self-report). Participants who were officially diagnosed with any learning difficulty, mental disability or any other impairment that could affect the cognitive measures (e.g. hearing-loss, colour-blindness), were excluded. Participants who scored very poorly were also excluded. Prior to the examination the participants signed online a consent form for their participation in the study. The participants gave written informed consent agreeing that their participation was voluntary and that they could withdraw at any time, without giving a reason and without cost. Due to the specific type of the current research, demographic data such as age, gender, or occupation were selected. Since these are considered personal data, the European Union law that exists since 28 May 2018 was applied. According to the law, the use of sensitive personal data is allowed only due to research reasons. Therefore, the participants were informed accordingly, and they also agreed that their personal data could be deleted from the web-database after a written request. The data collection was carried out from February 2021 to April of the same year.

3.1.3 Instruments

For the evaluation of the Verbal Working Memory, a Digit Span Forward and Digit Span Backward (Wechsler, 1997), as well as the Verbal Fluency Task (Kosmididis, Vlahou, Panagiotaki, Kiosseoglou, 2004) were administered. The evaluation of the

Executive Functions was conducted with the implementation of the Stroop Test (Golden & Freshwater, 2002). Finally, for evaluating reading comprehension, three passages were selected from the International English Language Testing System (IELTS) standardized examination.

Working Memory Measurements

In order to evaluate working memory, we assessed the Digit Span Forward, the Digit Span Backward (Weschler, 1997), and the Verbal Fluency Task (Kosmidis et al., 2004). For evaluating the executive functions, a Stroop test (Golden & Freshwater, 2002) was administered.

Digit Span (Forward and Backward span)

The Digit Span is a subtest of the Weschler Adult Intelligence Scale (WAIS) and the Weschler Memory Scales (WMS). The Digit Span Forward consists of eight complex gradient arithmetic sequences while the Digit Span Backward consists of seven. The examiner read a sequence of numbers and the participant had to repeat the same sequence in order (Digit Span Forward) or in a reverse order (Digit Span Backwards). For each pair of sequences, the first row is Attempt 1 and the second row is Attempt 2. Each arithmetic sequence is valued with one point. If the participant failed both attempts of the same pair, then the evaluation was stopped. The examiner had to provide the Digit Span Backward, even if a participant scored zero points in the Digit Span Forward.

Verbal Fluency task

A Verbal Fluency task (Kosmidis et al., 2004) was administered consisting of two conditions. Participants were asked to produce as many words as they could in 60 seconds. The test is standardized in Greek population. Participants need to retrieve words of their language, which undoubtedly requires them to access their mental lexicon, and they need to focus on the task, select words meeting certain constraints and avoid repetition, which certainly involves executive control processes.

In the first condition the participants were asked to produce as many animals as they could. In the second condition the participants were asked to produce as many words as they could that they started with the Greek letter “χ”. The participants were instructed to avoid repetitions and in the second condition they were also asked to avoid using proper names and a variance of the same word.

Executive Function

In order to examine the Executive Functions of the participants a Stroop test was administered. More specifically, the Stroop Test was used to measure and evaluate participants' inhibitory control. The purpose of the Stroop test is to measure the ability the participant has to inhibit and switch a response.

Stroop Test

The Stroop test that was administered consisted of five columns, 20 words each. The words were Greek colours and each word was written with different colour. The colours were blue, red, and green. There were three conditions of 60 seconds each. In the first condition the participants were asked to read the words that were written starting with the first column and reading up to the fifth, or until the time was up. In the second condition participants were asked to name the colour that the word was written with, while in the third condition participants were asked to read the word and then name the colour that it is written with. Each correct answer was scored with one point.

Reading Comprehension Evaluation

The passages for the reading comprehension study were selected from the International English Language Testing System (IELTS) books. We chose the passages for this examination as they are being used for evaluating reading comprehension in adults. Three passages were selected, specifically the passage *The rocket: From the East to the West*, *What do whales feel*, and *The Scientific Method*. Those passages were chosen in our try to minimize any background knowledge use from the participants. Specifically, each text was followed by five multiple choice questions and an extra question for evaluating the participants' feeling of confidence. The passages were ordered in an increasing difficulty as they were

ordered in the International English Language Testing System (IELTS) books. Participants were instructed that after reading the passage, to answer the multiple-choice question without going back to the passage looking for the answers. The participants had to answer to a total of 15 questions. After answering the questions of the first passage the participants moved on to the second and later at the third

3.2 Results

The data were analysed using the SPSS 23. Initially, in an attempt to evaluate the data of the current study we evaluate mean differences of the three neurodevelopmental groups in order to evaluate their cognitive performances in all working memory tasks and executive measurements as well. Table 2 presents the average and standard deviations of all the participants regarding their performances in all cognitive measurements Working Memory

For the evaluation of the working memory, a Digit Span Forward and Backward, and a Verbal Fluency task were administered. A comparison between the means of the two language groups in each of the working memory tasks was conducted. The comparison revealed that bilinguists were better in the verbal fluency task for both of the conditions; the category condition (bilinguists $M=25.97$, monolinguals $M=24.37$) and the letter condition (bilinguists $M=16.50$, monolinguals $M=12.27$). Also, bilinguists performed better in the digit span forward ($M=10.23$) and the digit span backward ($M=6.83$), when compared to their monolingual pairs ($M=9.43$; $M=5.50$).

In the next step of statistical analysis, we attempt to evaluate the first hypothesis according to which, bilinguists will have better performance at the Digit Span Task when compared to their monolingual peers. A multivariate statistical analysis was administered and it revealed that there is a significant difference in the Digit Span Backward ($F(1,58)=10.334$, $p < 0.05$) and the letter-condition in the Verbal Fluency task ($F(1,58)= 23.646$, $p < 0.05$). However, there was not any significant difference in the Digit Span Forward ($F(1,58) = 2.889$, $p > 0.05$) and the category-condition of the Verbal Fluency task ($F(1,58)= 1.530$, $p > 0.05$). Therefore, the findings partially confirmed the first research hypothesis.

Table 2. Mean scores, Standard Deviation, minimum and maximum values, and kurtosis and skewness scores of the cognitive measures by group.

	Bilingual Students						Monolingual Students					
	M	SD	Min	Max	Kur	Ske	M	SD	Min	Max	Kur.	Ske.
Digit Span Forward	10.23	2.34	7	16	0.82	1.17	9.43	1.07	8	11	-1.14	.275
Digit Span Backwards	6.83	2.08	5	13	1.75	1.50	5.50	.900	3	8	2.46	.000
Verbal Fluency (Category-condition)	25.97	5.39	18	38	-.597	.429	24.37	4.63	18	38	1.88	1.22
Verbal Fluency (letter-condition)	16.70	3.90	10	25	-.332	.513	12.27	2.74	5	17	.748	-.956
Stroop Part A	97.30	8.58	58	100	16.04	-	63.67	22.49	37	100	-1.30	.590
Stroop Part B	60	12.74	39	87	-.490	.368	60.63	8.20	40	76	.214	-.161
Stroop Part C	37.23	8.27	22	54	-.822	.156	32.07	4.66	26	48	3.82	1.75

Notes: M= Mean, SD= Standard Deviation, Min= Minimum value,

Max= Maximum value, Kur=Kurtosis scores, Ske=Skewness scores.

Executive Functions

In the next step of statistical analysis, we attempt to evaluate our second hypothesis according to which bilinguists will outperform monolinguals in the executive function task. A comparison between the means showed that bilingual participants performed better in the first (M=97.30) and the third condition (M=37.23) of the Stroop test, when compared to their monolingual peers (M=63.67; M=32.07 accordingly). In the second condition monolinguals (M=60.63) seem to perform slightly better than

bilectals ($M=60$). A multivariate analysis was also administered and it revealed that the difference in the first ($F(1.58)=58.528, p<0.05$) and the third ($F(1.58)= 8.874, p<0.05$) condition of the Stroop Test was statistically significant, while there was not any statistical significance for the difference in the second condition ($F(1.58)= 0.52, p>0.05$). Thus, the findings also partially confirmed the second hypothesis that bilectals will perform better in the executive function task when compared to monolinguals.

Reading Comprehension

Descriptive statistics were administered to see the differences on each passage. The results can be shown in Table 3. Monolinguals performed slightly better than their bilingual peers. Specifically, monolinguals performed better in Passage 1 ($M=2.87, SD 1.33$; bilectals $M 2.63, SD 1.32$) in Passage 2 ($M=3.80, SD 1.15$; bilectals $M3.67 SD 1.24$) and in Passage 3 ($M 3.27, SD 1.08$; bilectals $M 3.10, SD 1.12$). A multivariate statistical analysis was administered in an attempt to evaluate possible differences between the two groups which according to our third hypothesis bilectals will register better performance in comparison with monolingual participants in all reading comprehension task. The statistical analysis revealed that the difference between the groups was not significant for none of the passages (Passage 1 $F(1.58)= .462, p> 0.05$; Passage 2 $F(1.58)= .185, p>0.05$; Passage 3 $F(1.58)= .342, p>0.05$) and that there was not any language effect on reading comprehension. As a result, the findings did not confirm the hypothesis that the bilectal group will perform significantly better than the monolingual group. It should be also noted here, that when comparing the means of the feelings of certainty there was not any difference.

Table 3. Mean scores and the standard deviation for each passage and its feeling of confidence by group.

	Passage 1		Passage 2		Passage 3		FoC Pas 1		FoC Pas2		FoC Pas 3	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Monolinguals	2.87	1.33	3.80	1.15	3.27	1.08	3.23	.817	3.07	.785	2.83	.648
Bilectals	2.63	1.32	3.67	1.24	3.10	1.12	3.03	.718	3.17	.834	2.70	.877

Notes: M=Mean, SD= Standard Deviation, Passage 1 "The Rocket: From East to West", Passage 2 "What do whales feel", Passage 3 "The Scientific Method", FoC= Feeling of Confidence.

Chapter 4

Discussion

The aim of the present master's dissertation was to examine whether there is a bilingual advantage on bilinguists over their monolingual peers. The literature is mainly focused on children and therefore this master's dissertation aims to shed a light into the bilingual advantage of young adults. Furthermore, this master's dissertation also aims to shed a light to the question whether there is an effect of bilinguism on reading comprehension of the foreign language, in our case English passages. For the purposes of the study 30 monolinguals and 30 bilinguists participated. This master's dissertation administered the Digit Span Forward and Backwards, and a verbal fluency task to measure the working memory capacity of the participants.

The evaluation of the first hypothesis revealed that bilinguist young adults performed better than their monolingual peers in all the working memory tasks as revealed from the mean differences of performances for both groups in all cognitive measures. However, only the Digit Span Backward and the letter-condition of the Verbal Fluency Task were statistically significant. This finding is in line with Zang, Kalashnikova, and Antoniou's (2019) assumption that bilinguists might perform better at the verbal fluency letter-condition than the category condition due to the enhanced executive function skills. What is more, Anton, Carreiras, and Dunabeitia (2019) also found that bilinguism improves working memory, and this advantage is more apparent when the task is more demanding, like in our case the digit span backward. This finding partially confirms the first hypothesis that bilinguists are better in working memory when compared to their monolingual peers, especially in more demanding tasks that require more complex processing and retrieval. Grundy and Timmer (2017) referred to this bilingual advantage on working memory as the

result of the bilinguals' experience of constantly managing two different languages. The findings of this study support the notion of enhanced working memory capacity, and it seems that managing two different varieties of the same language, has the same effect as bilingualism.

It should be noted here that in the Verbal Fluency task participants were informed that they would only have 60 seconds to produce the word, and therefore this might pose an extra stress factor to their performance. According to literature review, this finding is in line with a number of similar research studies (Adescope, Lavin, Thomson, & Ungerleider, 2010; Speidel, 1993; as referred by Sofologi et al., 2020). In particular, researchers attribute the results of the findings to the simultaneous activation of the two languages. In addition, they argue that the mechanism with which bilinguals are led to cognitive change is based, mainly, on the need to focus their attention on the language they need. Nevertheless, this finding does not reflect an advantage in their performance in verbal memory tests. This research finding indicates that working memory is a separate function in itself and does not belong to all of the executive functions.

Additionally, based on Rai, Loschky, Harris, Peck, and Cook (2011), stress increases the cognitive demands on the working memory resources and therefore reduces the working memory capacity. The superior performance of bilinguals over monolinguals is also supported by the study of Oswald, Schattin, von Bastian, and Souza (2018: 17) who provided evidence that bilingualism is associated with better WM performance.

The second hypothesis supported that bilingual young adults will perform better in the executive function task in comparison to the monolingual group. The findings of the present master's dissertation revealed that bilingual participants performed better in the first and the third condition of the Stroop test, while in the second condition monolinguals performed slightly better. The difference in the second condition was not significant while in the first and the third condition it was significant. This finding also partially confirms the second hypothesis that bilinguals perform better in executive function tasks when compared to monolinguals. However, the finding that bilinguals performed better in working memory and

executive functions tasks lends support from Kyriakou et al. (2020) who found that bilingual young adults performed better in different executive control tasks than their monolingual peers. Furthermore, Poarch, Vanhove, and Berthele (2019) who examined German population found that the bilingual young adults displayed better performance in the executive function skills when compared to their monolingual peers. Also, the current findings lend support from other studies that were carried out in young children. For example, Antoniou et al. (2016: 20), examined monolingual, bilingual, and monolingual children and they found that the bilingual children outperformed their monolingual peers in the executive control tasks. One possible interpretation is that this continual use of inhibition, when using the foreign /second, third, etc. language(s) contributes to faster inhibition and thus to the fewer errors observed in multilinguals in the third part of the Stroop test. Additionally, it is well-known that the use of foreign languages gives an advantage to bilinguals, multilinguals and linguists - over monolinguals - as concerning their inhibitory control (Sofologi et al., 2020; Ghazi-Saidi & Adrover-Roig, 2015). These findings are in line with the hypothesis put forward at the beginning of this research, as well as with the findings of other similar research (Bialystok, Luk, Peets & Yang, 2010:23 ; Costa, Hernandez & Sebastian-Galles, 2008:14)

Finally, the third hypothesis was that bilingualism will positively affect reading comprehension of L2. The language profile of the participants (bilinguals and monolinguals) did not have any effect on the reading comprehension of the English Passages we used in this study. Therefore, the hypothesis that bilinguals would perform better than monolinguals was not confirmed. This might be due to the fact that participants were evaluated in English comprehension texts and despite their self-report of their level, some participants might underestimate or overestimated their language abilities in English. In addition to this Alptekin and Ercetin (2011) suggested that in studies that examining reading comprehension in L2 should take into consideration not only the L1 working memory but the L2 working memory as well. What is more, Adams and Shahnazari-Dorcheh (2013) mentioned that based on previous studies, L2 working memory and L2 reading comprehension success are linked. Therefore, maybe the bilingual participants, despite the fact that they had higher working memory when compared to their monolingual peers, the working memory in L2 might be lower, and thus not having a better performance than

monolinguals. A future study could also measure L1 and L2 working memory in order to shed a light to the question whether working memory capacity differs depending on the language an individual use.

The purpose of this study was to examine whether bilinguales perform are better in working memory and executive function and whether bilingualism positively affects reading comprehension in second language. Our findings suggest that bilinguales perform better in specific working memory and executive functions tasks and this further adds to the bilingual advantage which seems to extend to bilingualism as well. However, bilingualism did not seem to affect in either way reading comprehension in the foreign language. It is of vital importance to be able to understand the language profiling of bilinguales and the benefits that bilingualism comes with in order to embrace the different language varieties, instead of characterizing them as informal and a-no-proper-way to speak.

By attempting to illustrate the complex framework of bilingualism in adult populations, this study sought to clarify the relationship between working memory and executive functions in academic students. The above findings indicate the need to further study the relationship between working memory and executive functions in adults. In that direction, it would help to provide more sensitive tools for measuring verbal working memory in bilingual populations in order to compare their performance with monolingual students.

Limitations

This master's dissertation was carried out under strange circumstances for everybody due to the pandemic of COVID-19. Specifically, the data collection was carried out during social restrictions and regulations. Nowadays, people are experiencing stress and anxiety due to the unprecedented circumstances we live in. As it is mentioned above, stress can be a factor that affects attention and working memory due to the fact that it poses an extra effort and cognitive load to an individual's working memory. Therefore, the results could have been differentiated under different circumstances. What is more, the data collection was carried out mostly by using social media and other platforms that allow video calls. In the

reading comprehension process, participants were instructed to read the passage and then answer the multiple-choice questions. The examiners made it clear that participants were not allowed to answer the questions by going back to the passage. Despite this information that was provided to the participants, due to the fact that the evaluation was carried out in distance, some participants might not follow the instructions. Therefore, a future study that allows an individual and in person examination might be better in order to fully control the reading comprehension process.

In addition to the reading comprehension, there was not any official measuring of the language proficiency of the participants in English. Therefore, a future study can use a proficiency test in order for the participants to be also divided according to their proficiency level. Finally, a study that would examine reading comprehension in Standard Modern Greek, might reveal different results of the impact of bilingualism in reading comprehension. Moreover, additional measures of literacy skills, including pragmatics, phonetics, discourse analysis, and writing skills, bear a strong relation to working memory and executive functions, thus providing a clear picture of a participants' cognitive profile. When it comes to the cognitive abilities of the participants, a future study can use more cognitive measurements in order to shed light to further cognitive tasks that bilinguals might or might not perform better than their monolingual peers.

Finally, future studies could include a larger sample of participants in order to be able to replicate and validate the findings of this master's dissertation. In an attempt to further investigate the bilingual advantage, future studies could also include a bilingual or a multilingual group as well. As far as it concerns the reading comprehension, a future study comparing Greek monolinguals and Cypriot-Greek bilingual participants, could include passages in Greek in order to examine the possible attribution of bilingualism in reading comprehension.

Today there is a demand for a variety of methods, approaches, and techniques which are necessary for helping bilingual students and adults, and which are also based upon a range of principles, pedagogies, and resources for teaching and developing literacies.

Appendix A

Cognitive Measures

A.1 Working Memory tasks

Digit Span Task

Οδηγίες: Παρακαλώ επαναλάβετε μετά από εμένα. Στο forward πρέπει να τα πει ο εξεταζόμενος με τη σειρά που τα λέει ο εξεταστής, ενώ στο backward με την αντίστροφη σειρά. Μετά από 2 αποτυχημένες προσπάθειες του εξεταζόμενου (και στο A και το B) σταματά η δοκιμασία

	Digits Forward Trial Item/Response	Trial Score	Item Score (0,1, or 2)	Digits Backward Trial Item/Response	Trial Score	Item Score (0,1, or 2)	
>	1.A. 1-7			1. A. 2-4			
	B. 6-3			B. 5-7			
	2. A. 5-8-2			2. A. 6-2-9			
	B. 6-9-4			B. 4-1-5			
	3. A. 6-4-3-9			3. A. 3-2-7-9			
	B. 7-2-8-6			B. 4-9-6-8			
	4. A. 4-2-7-3-1			4. A. 1-5-2-8-6			
	B. 7-5-8-3-6			B. 6-1-8-4-3			
	5. A. 6-1-9-4-7-3			5. A. 5-3-9-4-1-8			
	B. 3-9-2-4-8-7			B. 7-2-4-8-5-6			
	6. A. 5-9-1-7-4-2-8			6. A. 8-1-2-9-3-6-5			
	B. 4-1-7-9-3-8-6			B. 4-7-3-9-1-2-8			
	7. A. 5-8-1-9-2-6-4-7			7. A. 9-4-3-7-6-2-5-8			
	B. 3-8-2-9-5-1-7-4			B. 7-2-8-1-9-6-5-3			
	8. A. 2-7-5-8-6-2-5-8-4			Digits Backward			
	B. 7-1-3-9-4-2-5-6-8			(Maximum = 30)			
Digits Forward Total Score				Forward		Backward	(Maximum = 30)
				+		-	

Verbal Fluency

Λεκτική Ευχέρεια

Χρονικό όριο: 60 sec το καθένα

Οδηγίες: **Θα ήθελα να μου πείτε όσο το δυνατόν περισσότερα και διαφορετικά ζώα μπορείτε μέσα σε 1 λεπτό.** Γράφετε όλες τις λέξεις που σας λένε, ακόμη και αν είναι λάθος ή επανάληψη.

Θα ήθελα να μου πείτε όσο τον δυνατόν περισσότερες και διαφορετικές λέξεις που να αρχίζουν με το γράμμα «Χ» που να μην είναι κύρια ονόματα (δηλαδή ονόματα ανθρώπων, πόλεων, ημερών) και να μην είναι παραλλαγή της ίδιας λέξης (π.χ., τραπέζι, τραπεζάκι). Γράφετε όλες τις λέξεις που σας λένε, ακόμη και αν είναι λάθος ή επανάληψη.

Ζώα	Χ

Appendix B

Reading comprehension evaluation

Passage 1: The Rocket: From East to West

A

The concept of the rocket, or rather the mechanism behind the idea of propelling an object into the air, has been around for well over two thousand years. However, it wasn't until the discovery of the reaction principle, which was the key to space travel and so represents one of the great milestones in the history of scientific thought, that rocket technology was able to develop. Not only did it solve a problem that had intrigued man for ages, but, more importantly, it literally opened the door to exploration of the universe.

B

An intellectual breakthrough, brilliant though it may be, does not automatically ensure that the transition is made from theory to practice. Despite the fact that rockets had been used sporadically for several hundred years, they remained a relatively minor artefact of civilisation until the twentieth century. Prodigious efforts, accelerated during two world wars, were required before the technology of primitive rocketry could be translated into the reality of sophisticated astronauts. It is strange that the rocket was generally ignored by writers of fiction to transport their heroes to mysterious realms beyond the Earth, even though it had been commonly used in fireworks displays in China since the thirteenth century. The

reason is that nobody associated the reaction principle with the idea of travelling through space to a neighbouring world.

C

A simple analogy can help us to understand how a rocket operates. It is much like a machine gun mounted on the rear of a boat. In reaction to the backward discharge of bullets, the gun, and hence the boat, move forwards. A rocket motor's 'bullets' are minute, high-speed particles produced by burning propellants in a suitable chamber. The reaction to the ejection of these small particles causes the rocket to move forwards. There is evidence that the reaction principle was applied practically well before the rocket was invented. In his *Noctes Atticae* or *Greek Nights*, Aulus Gellius describes 'the pigeon of Archytas', an invention dating back to about 360 BC. Cylindrical in shape, made of wood, and hanging from string, it was moved to and fro by steam blowing out from small exhaust ports at either end. The reaction to the discharging steam provided the bird with motive power.

D

The invention of rockets is linked inextricably with the invention of 'black powder'. Most historians of technology credit the Chinese with its discovery. They base their belief on studies of Chinese writings or on the notebooks of early Europeans who settled in or made long visits to China to study its history and civilisation. It is probable that, some time in the tenth century, black powder was first compounded from its basic ingredients of saltpetre, charcoal and sulphur. But this does not mean that it was immediately used to propel rockets. By the thirteenth century, powder-propelled fire arrows had become rather common. The Chinese relied on this type of technological development to produce incendiary projectiles of many sorts, explosive grenades and possibly cannons to repel their enemies. One such weapon was the 'basket of fire' or, as directly translated from Chinese, the 'arrows like flying leopards'. The 0.7 metre-long arrows, each with a long tube of gunpowder attached near the point of each arrow, could be fired from a long, octagonal-shaped basket at the same time and had a range of 400 paces. Another weapon was the 'arrow as a flying sabre', which could be fired from crossbows. The rocket, placed in a similar position to other rocket-propelled arrows, was designed to increase the range. A

small iron weight was attached to the 1.5m bamboo shaft, just below the feathers, to increase the arrow's stability by moving the centre of gravity to a position below the rocket. At a similar time, the Arabs had developed the 'egg which moves and burns'.

This

'egg' was apparently full of gunpowder and stabilised by a 1.5m tail. It was fired using two rockets attached to either side of this tail.

E

It was not until the eighteenth century that Europe became seriously interested in the possibilities of using the rocket itself as a weapon of war and not just to propel other weapons. Prior to this, rockets were used only in pyrotechnic displays. The incentive for the more aggressive use of rockets came not from within the European continent but from far-away India, whose leaders had built up a corps of rocketeers and used rockets successfully against the British in the late eighteenth century. The Indian rockets used against the British were described by a British Captain serving in India as 'an iron envelope about 200 millimetres long and 40 millimetres in diameter with sharp points at the top and a 3m-long bamboo guiding stick'. In the early nineteenth century the British began to experiment with incendiary barrage rockets. The British rocket differed from the Indian version in that it was completely encased in a stout, iron cylinder, terminating in a conical head, measuring one metre in diameter and having a stick almost five metres long and constructed in such a way that it could be firmly attached to the body of the rocket. The Americans developed a rocket, complete with its own launcher, to use against the Mexicans in the mid-nineteenth century. A long cylindrical tube was propped up by two sticks and fastened to the top of the launcher, thereby allowing the rockets to be inserted and lit from the other end. However, the results were sometimes not that impressive as the behaviour of the rockets in flight was less than predictable.

F

Since then, there have been huge developments in rocket technology, often with devastating results in the forum of war. Nevertheless, the modern-day space programs owe their success to the humble beginnings of those in previous centuries who developed the foundations of the reaction principle. Who knows what it will be like in the future?

Answer the following questions:

1. What was the idea behind the rocket?
 - a. A mechanism that could allow humans to travel into space
 - b. A mechanism that could be used as powerful weapon for wars
 - c. A mechanism that could propel an object in the air

2. The greatest outcome of the discovery of the reaction principle was that:
 - a. Rockets could be propelled into the air
 - b. Space travel became a reality
 - c. A major problem had been solved.

3. According to the text, the greatest progress in rocket technology was made
 - a. From the 10th to the 13th centuries
 - b. From the 17th to the 19th centuries
 - c. From the 19th century to the present day

4. Who was the FIRST to invent or use the rocket launcher?
 - a. The Chinese
 - b. The British
 - c. The Americans

5. When were the rockets used for military use?
 - a. From the 17th century
 - b. From the 18th century
 - c. From the 19th century

Πόσο σίγουρος/η είσαι πως απάντησες σωστά στις ερωτήσεις? Βαθμολόγησε από το 1-5. (1 – καθόλου σίγουρη/ος, 2 – λίγο σίγουρη/ος, 3 – ούτε πολύ, ούτε λίγο, 4 – πολύ σίγουρη/ος, 5 – απόλυτα σίγουρη/ος)

Passage 2: What do whales feel?

An examination of the functioning of the senses in cetaceans, the group of mammals comprising whales, dolphins and porpoises

A

Some of the senses that we and other terrestrial mammals take for granted are either reduced or absent in cetaceans or fail to function well in water. For example, it appears from their brain structure that toothed species are unable to smell. Baleen species, on the other hand, appear to have some related brain structures but it is not known whether these are functional. It has been speculated that, as the blowholes evolved and migrated to the top of the head, the neural pathways serving sense of smell may have been nearly all sacrificed. Similarly, although at least some cetaceans have taste buds, the nerves serving these have degenerated or are rudimentary.

B

The sense of touch has sometimes been described as weak too, but this view is probably mistaken. Trainers of captive dolphins and small whales often remark on their animals' responsiveness to being touched or rubbed, and both captive and free-ranging cetacean individuals of all species (particularly adults and calves, or members of the same subgroup) appear to make frequent contact. This contact may help to maintain order within a group, and stroking or touching are part of the courtship ritual in most species. The area around the blowhole is also particularly sensitive and captive animals often object strongly to being touched there.

C

The sense of vision is developed to different degrees in different species. Baleen species studied at close quarters underwater - specifically a grey whale calf in captivity for a year, and free-ranging right whales and humpback whales studied and filmed off Argentina and Hawaii - have obviously tracked objects with vision underwater, and they can apparently see moderately well both in water and in air.

However, the position of the eyes so restricts the field of vision in baleen whales that they probably do not have stereoscopic vision.

D

On the other hand, the position of the eyes in most dolphins and porpoises suggests that they have stereoscopic vision forward and downward. Eye position in freshwater dolphins, which often swim on their side or upside down while feeding, suggests that what vision they have is stereoscopic forward and upward. By comparison, the bottlenose dolphin has extremely keen vision in water. Judging from the way it watches and tracks airborne flying fish, it can apparently see fairly well through the air-water interface as well. And although preliminary experimental evidence suggests that their in-air vision is poor, the accuracy with which dolphins leap high to take small fish out of a trainer's hand provides anecdotal evidence to the contrary.

E

Such variation can no doubt be explained with reference to the habitats in which individual species have developed. For example, vision is obviously more useful to species inhabiting clear open waters than to those living in turbid rivers and flooded plains. The South American boto and Chinese beiji, for instance, appear to have very limited vision, and the Indian manatee are blind, their eyes reduced to slits that probably allow them to sense only the direction and intensity of light.

F

Although the senses of taste and smell appear to have deteriorated, and vision in water appears to be uncertain, such weaknesses are more than compensated for by cetaceans' well-developed acoustic sense. Most species are highly vocal, although they vary in the range of sounds they produce, and many forage for food using echolocation¹. Large baleen whales primarily use the lower frequencies and are often limited in their repertoire. Notable exceptions are the nearly song-like choruses of bowhead whales in summer and the complex, haunting utterances of the humpback whales. Toothed species in general employ more of the frequency spectrum, and produce a wider variety of sounds, than baleen species (though the

sperm whale apparently produces a monotonous series of high-energy clicks and little else). Some of the more complicated sounds are clearly communicative, although what role they may play in the social life and 'culture' of cetaceans has been more the subject of wild speculation than of solid science.

1echolocation: the perception of objects by means of sound wave echoes.

Answer the following questions.

1. Choose the correct statement.
 - a. Terrestrial mammals and cetaceans share the exact same senses.
 - b. Some senses of terrestrial mammals are not present or fail to function in cetaceans.
 - c. Terrestrial mammals and cetaceans do not share any senses.

2. Which species don't have a stereoscopic vision?
 - a. Dolphins
 - b. Baleen species
 - c. Porpoises

3. Large baleen whales primarily use:
 - a. High-frequency sounds
 - b. Medium-frequency sounds
 - c. Low-frequency sounds

4. Which of the following have good sight both in water and in air?
 - a. Baleen whales
 - b. Bottlenose dolphins
 - c. Freshwater dolphins

5. Which of the following species are blind?
 - a. South American boto
 - b. Chinese beiji
 - c. Indian susu

Πόσο σίγουρος/η είσαι πως απάντησες σωστά στις ερωτήσεις? Βαθμολόγησε από το 1-5.

(1 – καθόλου σίγουρος/ος, 2 – λίγο σίγουρος/ος, 3 – ούτε πολύ, ούτε λίγο, 4 – πολύ σίγουρος/ος, 5 – απόλυτα σίγουρος/ος.)

Passage 3: The scientific method

A

'Hypotheses,' said Medawar in 1964, 'are imaginative and inspirational in character'; they are 'adventures of the mind'. He was arguing in favour of the position taken by Karl Popper in *The Logic of Scientific Discovery* (1972, 3rd edition) that the nature of scientific method is hypothetico-deductive and not, as is generally believed, inductive.

B

It is essential that you, as an intending researcher, understand the difference between these two interpretations of the research process so that you do not become discouraged or begin to suffer from a feeling of 'cheating' or not going about it the right way.

C

The myth of scientific method is that it is inductive: that the formulation of scientific theory starts with the basic, raw evidence of the senses - simple, unbiased, unprejudiced observation. Out of these sensory data - commonly referred to as 'facts' — generalisations will form. The myth is that from a disorderly array of factual information an orderly, relevant theory will somehow emerge. However, the starting point of induction is an impossible one.

D

There is no such thing as an unbiased observation. Every act of observation we make is a function of what we have seen or otherwise experienced in the past. All scientific work of an experimental or exploratory nature starts with some expectation about the outcome. This expectation is a hypothesis. Hypotheses provide the initiative and incentive for the inquiry and influence the method. It is in the light of an expectation that some observations are held to be relevant and some irrelevant, that one methodology is chosen and others discarded, that some experiments are conducted and others are not. Where is, your naive, pure and objective researcher now?

E

Hypotheses arise by guesswork, or by inspiration, but having been formulated they can and must be tested rigorously, using the appropriate methodology. If the predictions you make as a result of deducing certain consequences from your hypothesis are not shown to be correct then you discard or modify your hypothesis. If the predictions turn out to be correct then your hypothesis has been supported and may be retained until such time as some further test shows it not to be correct. Once you have arrived at your hypothesis, which is a product of your imagination, you then proceed to a strictly logical and rigorous process, based upon deductive argument — hence the term ‘hypothetico-deductive’.

F

So don’t worry if you have some idea of what your results will tell you before you even begin to collect data; there are no scientists in existence who really wait until they have all the evidence in front of them before they try to work out what it might possibly mean. The closest we ever get to this situation is when something happens by accident; but even then the researcher has to formulate a hypothesis to be tested before being sure that, for example, a mould might prove to be a successful antidote to bacterial infection.

G

The myth of scientific method is not only that it is inductive (which we have seen is incorrect) but also that the hypothetico-deductive method proceeds in a step-by-step, inevitable fashion. The hypothetico-deductive method describes the logical approach to much research work, but it does not describe the psychological behaviour that brings it about. This is much more holistic — involving guesses, reworkings, corrections, blind alleys and above all inspiration, in the deductive as well as the hypothetic component - than is immediately apparent from reading the final thesis or published papers. These have been, quite properly, organised into a more serial, logical order so that the worth of the output may be evaluated independently of the behavioural processes by which it was obtained. It is the difference, for example between the academic papers with which Crick and Watson

demonstrated the structure of the DNA molecule and the fascinating book *The Double Helix* in which Watson (1968) described how they did it. From this point of view, 'scientific method' may more usefully be thought of as a way of writing up research rather than as a way of carrying it out

Answer the following questions.

1. Choose the correct statement.
 - a. The scientific method is inductive
 - b. The scientific method is hypothetico-deductive
 - c. The scientific method is both hypothetico-deductive and inductive.

2. The inductive scientific method:
 - a. Is based on raw evidence
 - b. Is biased by your hypothesis
 - c. Is based on your subjective observation

3. All scientific work starts with:
 - a. No expectations of the outcome
 - b. Some expectations of the outcome
 - c. Already know the outcome

4. Based on Watson (1968) the scientific method:
 - a. may be more useful to explain the actual carrying out of a research
 - b. may be equally useful for both to explain the writing of a research paper and to actually carry it out.
 - c. May be more useful for writing up a research paper than carrying out.

5. What is the main purpose of the writer?
 - a. To encourage PhD students not to cheat while carrying out research
 - b. To explain PhD students the logic which the scientific research paper follows.
 - c. To help PhD students by explaining different conceptions of the research process.

Πόσο σίγουρος/η είσαι πως απάντησες σωστά στις ερωτήσεις? Βαθμολόγησε από το 1-5. (1 – καθόλου σίγουρη/ος, 2 – λίγο σίγουρη/ος, 3 – ούτε πολύ, ούτε λίγο, 4 – πολύ σίγουρη/ος, 5 – απόλυτα σίγουρη/ος)

Appendix C

Consent Form

Δήλωση συγκατάθεσης για συμμετοχή στην Μεταπτυχιακή Έρευνα.

Η παρούσα έρευνα γίνεται στα πλαίσια της μεταπτυχιακής μου διατριβής με θέμα "Οι επιπτώσεις του δι-διαλεκτισμού στην κατανόηση κειμένου στη δεύτερη γλώσσα". Η παρούσα έρευνα επιβλέπεται από την Δρ. Μαρία Σοφολόγη, Μεταδιδακτορική ερευνήτρια, Λέκτορας στο Μεταπτυχιακό Πρόγραμμα Γνωστικά Συστήματα (MSc Cognitive Systems) στο Ανοιχτό Πανεπιστήμιο Κύπρου. Σκοπός της έρευνας είναι να εξετάσει τις επιπτώσεις του δι-διαλεκτισμού και της διγλωσσίας στην κατανόηση κειμένου στην δεύτερη γλώσσα. Δι-διαλεκτισμός είναι η απόκτηση δύο διαλέκτων της ίδια γλώσσας, όπως συμβαίνει στην περίπτωση των Κυπριακών.

Η έρευνα χωρίζεται σε δύο μέρη. Το πρώτο μέρος αποτελείται από τις μετρήσεις γνωστικών λειτουργιών, οι οποίες φαίνονται να ενισχύονται στην περίπτωση του δι-διαλεκτισμού, καθώς επίσης είναι σημαντικές για την κατανόηση κειμένου. Το πρώτο μέρος διαρκεί περίπου 15 λεπτά.

Το δεύτερο μέρος αποτελείται από τρία κείμενα στην Αγγλική γλώσσα. Μετά από κάθε κείμενο ακολουθούν πέντε ερωτήσεις κατανόησης καθώς και μια ερώτηση αυτοαξιολόγησης. Το δεύτερο μέρος διαρκεί περίπου 1 ώρα.

Η συμμετοχή σας στην έρευνα συνεπάγεται με την συγκατάθεση σας για δημοσίευση των δεδομένων και των αποτελεσμάτων, με την προϋπόθεση την προστασία των ευαίσθητων προσωπικών σας δεδομένων. Τα προσωπικά σας δεδομένα θα χρησιμοποιηθούν από την ερευνήτρια (Γεωργία Ευσταθίου) και μόνο για σκοπούς επικοινωνίας μαζί σας. Επίσης η συγκατάθεση σας συνεπάγεται με το ότι η συμμετοχή σας είναι εθελοντική. Για τυχόν περισσότερες πληροφορίες ή διευκρινήσεις επικοινωνήστε με την Γεωργία Ευσταθίου στο email gefsta02@gmail.com

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