GRAU D'ANGLÈS

Treball de Fi de Grau

Foreign Language Acquisition in a Mature Adult's Brain

VALERIA PABLO SOLORZANO

UNIVERSITAT ROVIRA I VIRGILI

DEPARTAMENT D'ESTUDIS ANGLESOS I ALEMANYS

2023

Foreign Language Acquisition in a Mature Adult's Brain

VALERIA PABLO SOLORZANO

TUTORA: Dra. Marni Lynne Manegre

UNIVERSITAT ROVIRA I VIRGILI

DEPARTAMENT D'ESTUDIS ANGLESOS I ALEMANYS

2023

ABSTRACT

This study addresses how the acquisition of a foreign language as an adult affects their brain by conducting a descriptive and an experimental study in the format of research on recent theories about the topic and whether if the acquisition is beneficial or not to their brain connections. The hypothesis is that mature adults can learn a new foreign language, although their capacity may vary due to cognitive changes and prior language exposure. This was tested across eighteen mature adults that have learnt or are learning a foreign language using a questionnaire made of twenty different questions. The results suggest that learning a foreign language as an adult rewires their brain and is beneficial for their cognitive health. From this study, we can determine that the ability to learn a foreign language exists in mature adults, although the learning method and results may differ from those of younger students. These findings advance our knowledge of the specific difficulties and variables that affect language learning in mature people, emphasizing the significance of customizing language learning strategies to their cognitive traits and linguistic backgrounds.

Keywords: Foreign Language Acquisition, Bilingual Brain, Mature Adults, Brain Plasticity, Broca's and Wernicke's Area.

ACKNOWLEDGEMENTS

I would like to thank my supervisor for this study Dra. Marni Lynne Manegre for her fully support throughout the work and for being there since day 1 with her endless guidance and motivation to carry out this project. Also, I would like to thank those teachers who also gave us preparation and guidelines to follow for completing this study. And last but not least, thanks to my family and friends who have been present during this time and who gave me advice to complete this project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Introduction

At any age, learning and mastering a second language is a remarkable accomplishment. However, the process of language learning in mature adults (generally referred to as people beyond the age of 30) is an interesting field of study that has drawn more attention lately. In addition to adding to our knowledge of cognitive capacities, knowing how the mature adult brain learns and processes a new language has important effects for educational services, language pedagogy, and learning techniques.

While it is generally accepted that learning a language gets harder as you get older, current research has revealed a more complex point of view. Mature adults' ability to change and rewire their brains, known as neuroplasticity, is essential for language development. Although mature people have distinct cognitive resources and experiences that can help affect language acquisition, there are several limits compared to the language acquisition process in children, such as less neuroplasticity.

The understanding of the cognitive advantages that mature adults have is one important element in the language acquisition process. Mature adults can adapt their current cognitive structure to new linguistic structures and concepts thanks to life experiences, including problem-solving ability and critical thinking abilities. This past knowledge can accelerate learning and improve comprehension.

Additionally, neuroscientific studies have shown the neuroplastic alterations that take place during language learning in the mature adult brain. Research using neuroimaging methods,

such as functional magnetic resonance imaging (fMRI), has shown that the adult brain is capable of reorganizing neural networks and forming new connections in response to language learning. These results negate the idea that neuroplasticity dramatically declines after childhood and imply that mature adults have the capacity to rewire their brains to adapt new linguistic structures.

I've divided this paper into several sections to illustrate the entire process of how learning a new language as an adult affects their brain, in order to conduct this study. First, I dive into the recent theories about this topic and after this point I focus on what differences are between the monolingual and bilingual/multilingual brain. Then, I move on to explain what the difference of age implicates when learning a new language and the advantages and disadvantages every age has. After having assumed these points, I relate what actual benefits learning a new language has. The last sections are the hypothesis of this study and its methodology and results, the discussion of the whole thesis and its found limitations and to finish the conclusion.

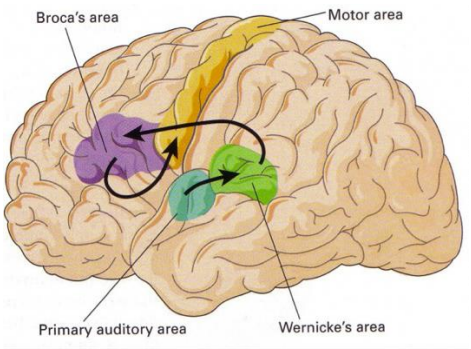
1.1 Scientific Background

The process of language acquisition in a mature adult's brain is similar to that of the process in a child's brain, although the process may be more difficult due to the different neural pathways that are formed over time. As adults, we are less likely to be able to imitate the sounds of a language without much effort as the speech patterns have already been established. (Kuhl P.K., 2010)

When learning a new foreign language, many different areas of the brain are involved. One of the brain's main language centers is Broca's area. It is one of the brain's main centers, which is also known as the motor and production of speech area. Also, works in a different way with native and foreign language acquisition. (ARC Journal of Neuroscience, 2017, p. 10).

The most active areas of the brain that are in charge of the language storage are found in the principal hemisphere of the temporal lobe, but Broca's area is a good example of how this network is divided throughout different parts of the brain. Broca's area is located in the lower back section of the frontal lobe, close to the speech centers and the auditory canal. (BiologyDictionary.net Editors, 2020)

Figure 1. *Areas of the Brain*

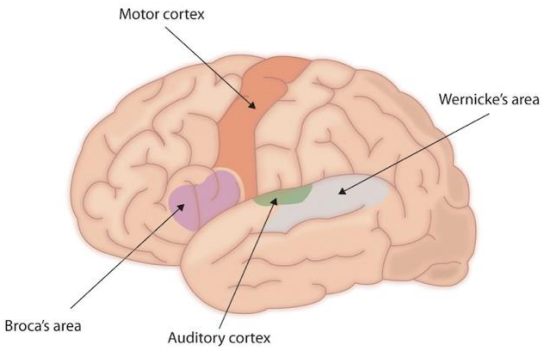


(Image retrieved from: https://twitter.com/qwizbowl/status/1169237182441238529)

However, other parts of the brain are involved in language learning, including the frontal lobe, temporal lobe and parietal lobe (Wernicke's area), which process auditory information, store language information and control language comprehension and production. (ARC Journal of Neuroscience, 2017, p. 10).

Wernicke's area is in charge of phonologic retrieval, a fundamental part of the development of the speech production. This permits the mental demonstration of phonemes, which are communicated in their temporal order. This area has the role in being able to read aloud, repeat speech, and retrieve words. (Cherry. K, 2023)

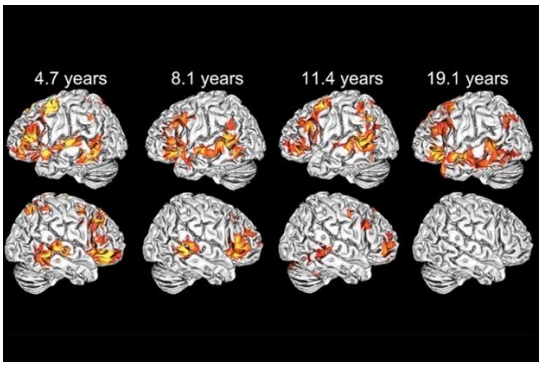
Figure 2. *Broca's and Wernicke's area*



(Image retrieved from: https://theconversation.com/what-sign-language-teaches-us-about-the-brain-29628)

Many scientific studies have affirmed that the parts of the brain that are active during a foreign language learning, are different before and after the critical age of 12 years. For example, after the age of 12 the language-related areas of the brain that assist in learning English as a foreign language, were broader and more stimulated than the areas of the brain before the age of 12 according to the usage of fMRI. (ARC Journal of Neuroscience, 2017, p. 11).

Figure 3. *Activation of the Brain Hemispheres*



(Image retrieved from: https://nypost.com/2020/09/09/kids-use-both-brain-hemispheres-to-process-language-unlike-adults-researchers-say/)

This affirms that foreign language learners after the initial age of 12 years produce speech mainly through supposition rather than understanding it, thus demanding the work of much more areas and action of the brain. Put differently, foreign language learners need to put more effort after the age of 12 years to learn intuitively rather than to learn consciously. (ARC Journal of Neuroscience, 2017, p. 11).

The human brain has plasticity, that is to say a capacity to alter the brain structure in response to a diversity of external stimuli. Hypothetically, outside stimuli can change the brains structures and purposes to execute high-level perceptive processes including learning a new language. (Li P, Legault J, Litcofsky KA, 2014)

Learning can motivate brain stem cells to create new cells and brain circuitry. Consequently, the brain's plasticity permits learners to overcome the difficulty after the age of twelve through choosing the effective learning techniques. (ARC Journal of Neuroscience, 2017, p. 11).

Memory can be mainly distributed into declarative memory and non-declarative memory. The first one recalls facts and events, personal information, and general knowledge. On the

contrary, non-declarative memory can be further divided into many categories: the most considered category, procedural memory, covers memory related with techniques, conducts, behavior, and emotional acquiring. (ARC Journal of Neuroscience, 2017, p. 11). For example, musical functioning and riding a bike are procedural memories. These two memories are collected in different brain areas; declarative memory is stored in the outside part of the brain while non-declarative memory is stored in the inside part of the brain. (ARC Journal of Neuroscience, 2017, p. 11).

When speaking a mother tongue, it is known to use the non- declarative memory while declarative memory is used when speaking a foreign language. Taking into consideration these kinds of memories, English and other foreign languages competences are efficiently acquired through the use of the procedural memory after the age of 12. (Hong et al., 2017).

1.2 Theoretical Review

1.2.1 Recent theories about the topic (2010 to today)

Neuroimaging studies with young bilinguals have determined that cognitive functioning on nonverbal communication tasks is related with the use of more dispersed brain circuits than those used by monolinguals (Garbin et al., 2010; Luk et al., 2010).

In older adults, there are statements that bilinguals have larger gray matter dimensions in left temporal cortex than monolinguals (Abutalebi et al., 2014), and greater white matter association between left and right frontal cortex (Luk et al., 2011). Both of them, the gray and white matter of the brain and spinal cord help form spinal areas. These pathways send nerve signs from the brain to the rest of the body. Knowing the most mutual areas can help from discern the source of the injury (Mercadante AA, Tadi P., 2022).

Though reduced white matter measures in bilinguals have also been discovered (Gold et al., 2013), in terms of brain function, only two studies have observed differences due to language knowledge in older adults. One found more dispersed patterns of resting functional connection between frontal and posterior areas of the brain in bilingual older adults, in comparison to monolinguals (Luk et al., 2011). Meaning that bilingualism may help to maintain a more flexible and adaptable brain network, which may help to mitigate some of these age-related declines. (Kim, S., Jeon, S. G., Nam, 2019)

The other study observed the stimulation during task substituting and discovered a wide age-related growth in activation of frontal regions, but that bilinguals had less over-recruitment, showing stimulation that more carefully look like that of young adults (Gold et al., 2013). The fact that bilinguals showed less over-recruitment in the frontal regions suggests that they may be able to perform cognitive tasks more efficiently, with less cognitive effort required compared to monolinguals (Grundy, J. G., Anderson, J. A. E., & Bialystok, E., 2017)

Bilingualism has also been proven to show a contribution to cognitive reserves (Schweizer et al., 2012). Also, the use of this one has been related to exclusive functioning benefits, which have been found in bilingual generations, even when the foreign language is assimilated after infancy (Costa and Sebastián-Gallés, 2014).

However, these cognitive benefits are questioned, as some studies have failed to demonstrate variances in cognition between monolingual and bilingual adults (Paap et al., 2014; von Bastian et al., 2016; Nichols et al., 2020). Remarkably, variances may be more evident in older adults, as young adults already function at their ultimate capacity (Bialystok et al., 2005).

Thus, investigation aiming on older adults that speak more than one language may have more advantages on the cognitive benefits associated with bilingualism. As an example, it has been affirmed that the constant use of more than one language could lead to superior cognition in older life (Bialystok et al., 2004). An improvement in declarative memory has been evidenced by a few studies conducted in elderly bilinguals (Ljungberg et al., 2013). Essentially, this means that bilingual adults show more, semantic verbal fluency, as well as higher general cleverness (Bak et al., 2014)

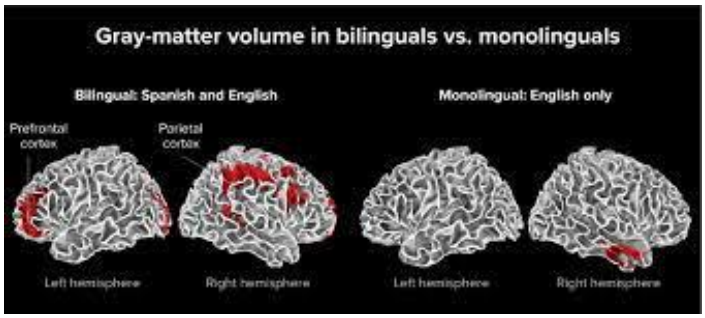
1.2.2 The bilingual and multilingual brain

The bilingual and multilingual brain is a fascinating topic of study, as it provides insight into how the brain processes different languages. As mentioned previously on the work, the bilingual brain possesses a number of advantages over the monolingual brain, such as enhanced problem-solving abilities, improved executive functioning, and higher academic achievement. Additionally, studies have indicated that speaking two or more languages can help to protect against cognitive decline in old age.

Bilingualism has been proven to avoid the natural deterioration of cognitive function and maintains what is called “cognitive reserve” (Bialystok E., 2021). This makes reference to the effective use of the brain systems to improve the functionality of the brain during aging. Being bilingual allows to this reserve to keeping the cognitive mechanisms working and by contributing to generate different brain networks to balance for those that were damaged throughout aging. Older bilinguals experience enhanced memory and executive control when compared to older monolinguals (Marian, V., & Shook, A., 2012).

When making a comparison of the activation patterns of the mother tongue and the second language of late bilinguals, varieties have been discovered in a diversity of different brain areas. The native language has shown superior activation compared to the second language in Broca's area (Golestani et al., 2006; Hals- band, 2006; Suh et al., 2007) and the cerebellum (Halsband, 2006), while the late-acquired second language has stimulated greater activation in the angular and supramarginal gyri (Halsband, 2006).

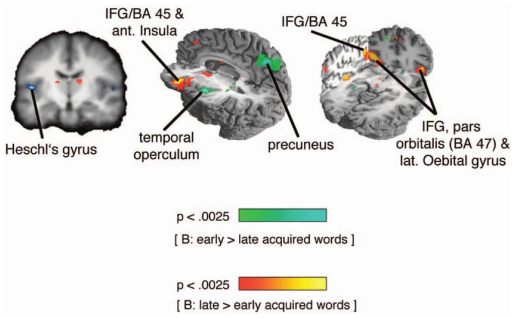
Figure 4. *Gray matter volume in bilinguals vs. monolinguals*



(Image retrieved from: https://knowablemagazine.org/article/mind/2018/how-second-language-can-boost-brain)

These results are consistent with neuroimaging investigation demonstrating that later-learned vocabulary in the mother tongue show increased neural activity compared to early learned words, in certain regions involving auditory-phonological assimilation and articulatory motor planning (A. Hernandez & Fiebach, 2006).

Figure 5. *Neural activity for early and late learned words in monolinguals*



(Image retrieved from: https://www.researchgate.net/figure/Neural-activity-associated-with-early-and-late-learned-words-Increased-activity-is_fig3_6244415)

When taking into consideration the different types of bilinguals, there are five variations. The first one is the simultaneous or compound bilingual, who has exposure to more than one different language since birth and early childhood. The languages acquired during this time period are learnt in a more natural way. Then, there is the sequential bilingual, who learns the second language after having already acquired their first language. This case can be due if the parental tongue differs from the dominant language in the community or in the educational system. (Byers-Heinlein & Lew-Williams, 2013).

Also, there is the coordinate bilingual, who speaks a different language at home but learns it in school (for example, at Catalonia's Catalan/Spanish schools). When switching between languages, these bilinguals use two sets of notions. And then the subordinate bilingual, adults who learn a second language by filtering it from their first language. (Mia Nacamulli, 2015).

1.2.3 Age differences when learning a language

When learning a new language, even when their linguistic information merely illustrates this patterns, young toddlers learn categorical norms and categorically adhere to natural language patterns. In comparison, mature adult language learners make a supposition of the patterns of the input. (Newport E.L, 2020)

Children who are older somewhere in the middle, exhibiting regular patterns slightly more frequently than they do in the input while also learning a variety. These findings suggest that learning outcomes vary depending on age and that many of the characteristics of natural

languages may be influenced by how young children behave as they learn their native tongues. (Newport E.L, 2020)

The loss in language acquisition ability at age 18 is thought to be caused by three main factors: social changes, interference from one's primary language, and ongoing brain growth. Kids often finish high school at 18 and begin college. After then, individuals might not have the same access to resources for learning a second language as they did when they were younger, such as time, opportunities, or learning environments. (Dana G. Smith, 2018).

Alternatively, it's likely that once one masters one language, the rules of that language become difficult to acquire in a second language. Finally, the ongoing brain changes that occur in early and late adolescence, may in some way make learning more difficult. (Dana G. Smith, 2018)

Many different neuroscientists and linguists have affirmed that the process of learning a new language is one of the most difficult things our brain can do. Some language functions of the brain can arrive to its peak during childhood, while other functions develop later. Surprisingly, other functions seem to have a peak during the ages of 50 and 75 years old. (Fitzpatrick, 2022).

Starting to learn a second language before the age of 7 years old, for children it can be acquired almost as a "mother tongue", due to their capacity of identifying new sounds. In other words, during childhood a lot of different phonemes are learnt. The brain of the child has not yet acquired all the different sounds a language can make, so when the infant listens for the first time a new language, he/she won't be influenced by other sounds. (Fitzpatrick, 2022).

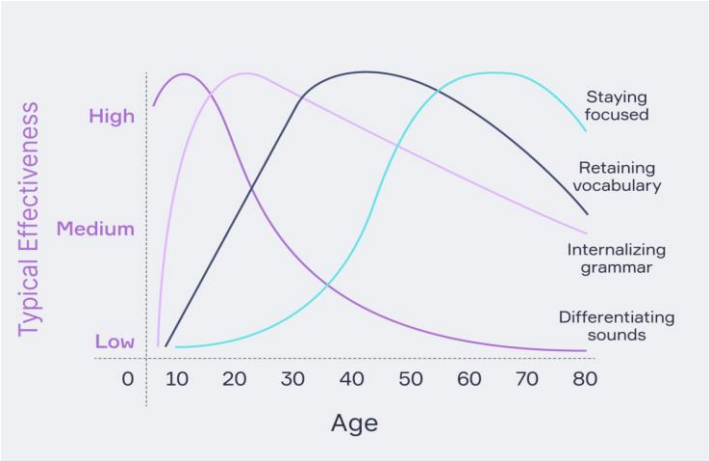
Focusing on the grammar aspect, the best age to master it is between the age of 10 and 18 years old. That is due to the almost total acquirement of the mother tongue. Also, it has been

proven that second language learning during the same period of time, results in an unconscious understanding of the new grammar of the second language. Them, other social aspects take place in the learning. Motivation rises during this time due to the desire to impress or acquire identity with the performance of the language. (Fitzpatrick, 2022)

During adulthood, language learning needs more translation. We are more used to think about what we want to say in our first language and translate it into the second language that we are learning rather than filtering it directly. In this period, we reach our peak in communication of our first language as we know what we want to express and when to express it. (Fitzpatrick, 2022)

As mentioned previously on the work, as we age several parts of memory begin to deteriorate. One significant finding is that even if precognitive foundations are not developed throughout childhood, procedural memory and the ability to learn new terminology do not deteriorate between the ages of 18 and 50 years old. (Fitzpatrick, 2022)

Figure 6. *Effectiveness of the language depending on age*



(Image retrieved from https://lingvist.com/blog/how-learning-a-language-changes-depending-on-your-age/)

1.2.4 Benefits on the brain after its acquisition

Now that we already know that the brain is made up of two different types of tissues: gray matter and white matter and that they focus on attention, intelligence, memory and language, let's see how they are developed after acquiring a new foreign language.

One of the main benefits is the effects it has on intelligence in general. Findings from the Centre for Cognitive Ageing at the University of Edinburgh show that reading, verbal fluency, and intellect all increase when one learns a new language. According to their research, speaking more than one language significantly affected reading comprehension and overall intelligence. The study, which involved different age groups, revealed clear gains in fluency, focus, and attention. (Albalooshi, 2019)

Of course, another of the main profits of learning a new language is the decrease of the probability of age-related cognitive decline and dementia. Cognitive flexibility is the capacity to modify one's thoughts and actions in response to constantly shifting external demands in order to achieve personal objectives. With aging, cognitive flexibility, which is essential for successfully navigating life's challenges, significantly decreases. However, recent research suggests that frequently using more than one language helps prevent dementia from developing as well as age-related cognitive diseases like Alzheimer's. (Dajani, D.R., & Uddin, L. Q., 2015)

Also, it has a big impact on the working memory, which is a term used to describe a cognitive structure made up of different brain regions that serves as a dedicated, temporary mental workspace for the organization, processing, and manipulation of information. The phonological loop, which deals with spoken and written content, stores information in a speech-based way, and supports speech production, is one of the parts of working memory. (Mcleod, 2023)

In response to trials, bilinguals responded more quickly and accurately demonstrating and advantage in several elements of executive functioning. The visuospatial span, which is associated with visual and spatial identification, a task unrelated to the language-processing portion of working memory, likewise showed superior performance than monolinguals. (Morales, J., Calvo, A., & Bialystok, E., 2013).

Lastly, the academic performance of bilingual learners may initially lag behind that of their monolingual counterparts, but after several years of immersion in language study, they catch up and exhibit the greatest benefits across the course. If students from minority-language backgrounds continue to learn and grow their original language, they tend to perform better academically in math and reading in English. For instance, kids in the United States who continued to study Spanish at their school outperformed their colleagues who did not take Spanish immersion classes in English and Math. (Albalooshi, 2019)

1.2.5 Hypothesis

According to the data collected on the theoretical part of this study, some of the research questions that were occurring overtime were:

- Is learning a foreign language as an adult more difficult than when we are younger?
- Is it actually beneficial for the brain to learn a new language?

Hypothesis statement:

- Mature adults have the ability to learn foreign languages, but that the process and effectiveness of language learning may differ from that of younger learners due to cognitive changes and prior language experiences.

2. Method

2.1 Materials

Before starting this thesis, I knew that I wanted to do extensive research, not only on the theoretical part but also on the practical side of the work. The main reason was to discover if the theory acquired throughout the project would actually relate with adult participants. Taking these points into consideration, I decided to prepare a questionnaire in Microsoft Forms format, which is composed by twenty different questions which are multiple choice, single choice, open ended and closed ended questions. These questions are made to know their age range, their number of languages acquired, their fluency and also if some aspect of their lives have change after acquiring a new foreign language.

The aim of this choice of methodology is to explore how learning a second language as an adult rewires their brain. I chose to complete the questionnaire in Spanish to avoid complications since the audience reached are mainly people from Spain who have learnt another language.

For ethical considerations, this study was approved by the URV ethics board with the ethics approval number CEIPSA-2023-TFG-0001.

2.2. Participants

The participants that responded in the questionnaire of this study were a total number of eighteen adults between the age ranges of 30 to 60 years old. This form was only sent to adults who have actually learnt or are learning a new foreign language. When it comes to their age, the majority of the participants that have answered are between 30 to 45 years old. Exactly the 67% of the participants were between that age range. Meanwhile the 28% were between 46 and 60 old and only the 6% of participants were plus sixty years old. This can be due to how the questionnaire was spread, which was mainly online.

Regarding the factor of gender, it was not taken much into consideration as during the development of the thesis it has not been mentioned whether if the acquisition of a foreign languages varies depending on the gender of the person.

2.3 Procedure

The participants of the study of this thesis were mainly Spanish people who during their years have learnt or are learning a new foreign language. They were asked through e-mail, WhatsApp chats and it also was spread by some friends and family to their acquittances and/or co-workers. The questionnaire was made as the theoretical part was being developed so it could actually cover all the points mentioned in twenty different questions.

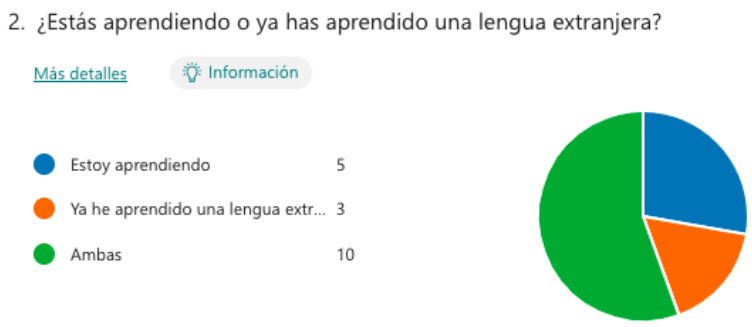
To gather the results in a clearer and easier way, the questionnaire was completed using Microsoft Forms from my part (see Appendix A for the complete questionnaire). Also, taking into consideration the most compelling way to attract a wider audience of participants. From the part of the participants, they answered to this questionnaire using their own technology devices such as smartphones, computers and tablets.

Before answering to this questionnaire, it was asked to participants to first complete an informed consent form (see Appendix B for the informed consent form). Regarding the time it took to complete the questionnaire, it was an amount of eight minutes per person.

3. Results

To follow this methodology, I chose to base the results of the questionnaire in a qualitative but also in a quantitative approach of research. With the qualitative way I analyzed each of the answers given by each participant according to the questions. On the other hand, with the quantitative approach, I analyzed the percentages by using graphs to represent how many and what participants responded to a certain type of answer.

Figure 7. *Asking people whether they have learnt and/or are learning a foreign language*



Question two above (Figure 7), asked whether the participants are learning or have already learnt a foreign language. Out of eighteen participants that answered, 10 of them answered that they are learning and also have already learnt a foreign language, representing a 56% of the graph. Meanwhile 28% of the participants answered that they are learning a language at the moment and the rest (17%) said that they have already acquired a language.

Question number three below (Figure 8) asks why they have learnt and/or are learning a new foreign language, now as adults. Being a multiple-choice question, the participants answered different options at once where the majority of them indicated that it is because of work reasons and for travelling, summing up a total of 52% of the graph. The second most popular reason between participants is because of fun, which represents a 21%. Meanwhile five people answered that it is because of studies and the other five, for another reasons.

Figure 8. *Asking people the reason why they have learnt or are learning a language as an adult*

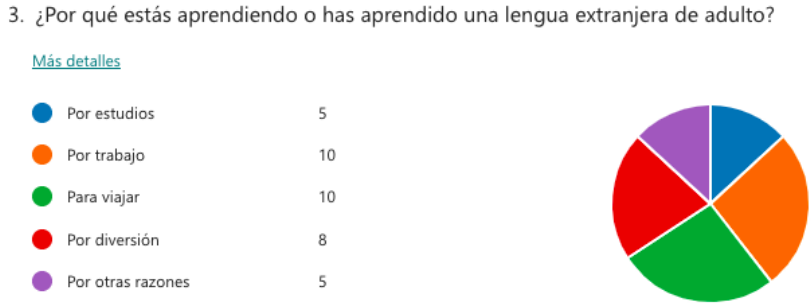
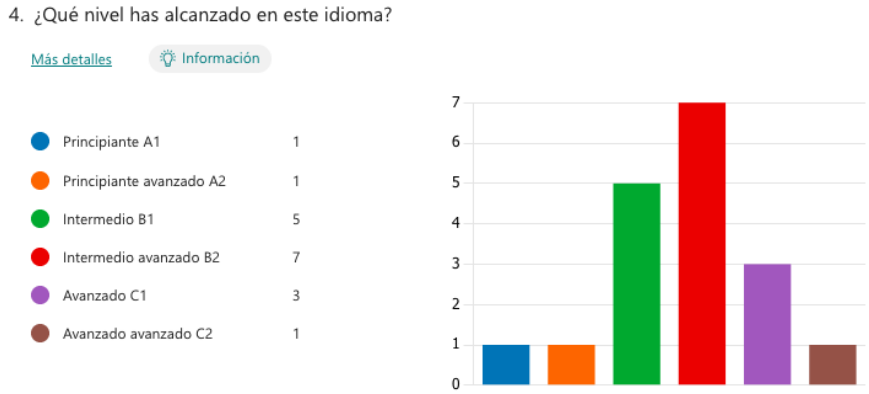
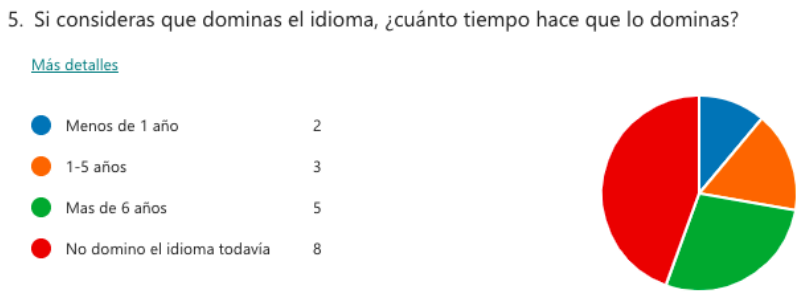


Figure 9. *Asking people what level they have reached in that language*



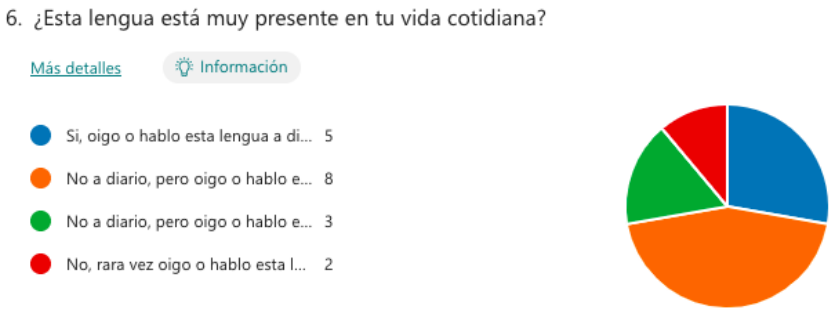
Question number four above (Figure 9), asked what level participants have accomplished in that foreign language. On the graph it can be seen that 7 out of 18 participants answered that they have reached a level of advanced intermediate B2. Five of them indicated that they have accomplished the B1 level and three of them the C1 level. The graph indicates that only one person has reached the C2 level and the remaining two participants they have reached the A1 and A2 level.

Figure 10. *Asking people the period of time they have been fluent on the language*



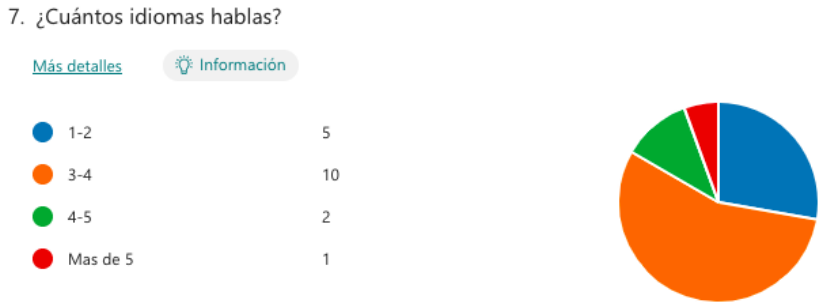
Question number five above (Figure 10), asked how long has been since they have been fluent on the language. A total of eight participants who represent the 44% of the graph, answered that they consider that they have not reached yet fluency on the language. The second most chosen option was that they have already been fluent over the past six years, representing the 28% of the graph. Then, three people answered that they have only been fluent between one and five years and only one person answered that it has been less than a year since they have been fluent on that language.

Figure 11. *Asking people if that language is present on their daily lives*



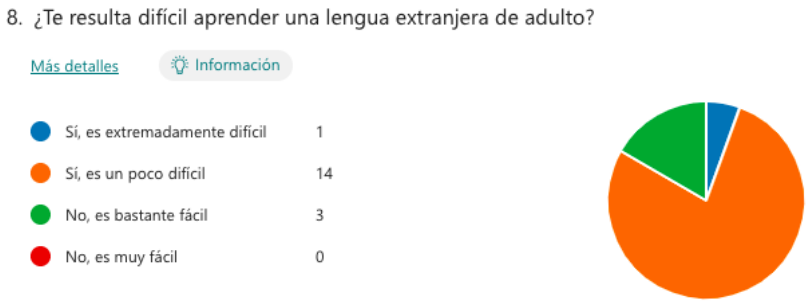
Question six above (Figure 11), asked if the foreign language they are learning or have already learnt is present in their lives. The most common answer was that it is not daily present, but they listen to it and speak it weekly. This option was chosen by eight people. The second most common answer was that it is of course very present in their daily lives and that they speak and listen to it every day. Then, three people answered that they speak and listen to it monthly and the remaining two participants affirm that they rarely listen or speak that language.

Figure 12. *Asking people how many languages they speak*



Question number seven above (Figure 12), asked how many languages participants speak and a total of the 56% of the graph have answered that they speak between three and four languages. The other 28% represent the people that have answered that they speak one to two languages. And the three remaining people have answered that they speak from four to more than five languages in total.

Figure 13. *Asking people if they find difficult learning a foreign language as adults*



Question number eight above (Figure 13) and question 9 below (Figure 14) are related. In question eight is asked whether they find difficult learning a new foreign language now that they are adults. Here the difference is very notorious. A total of the 78% of the graph answered that it is indeed a bit difficult but only 1 person answered that it is very difficult. The other 3 people remaining answered that is pretty easy and none of them indicated that it is very easy.

Moreover, on question number nine (Figure 14) below is asked why they find difficult or easy to learn a foreign language according to what they have answered on the previous question. A 22% of them indicated that they find it difficult because of time, another 17% because of work

and another 11% because of the age range they are in. Some of the individual answers are that they are more mentally structured, but that they do not learn languages structurally and that they acquire them by assimilation without being biased by patterns. Another participant that answered on the previous question that they found learning a foreign language pretty easy, affirmed that their way of learning nowadays is better than that taught when they were little and because there are more tools to help acquiring a language.

Figure 14. *Asking people why they find it difficult or easy*

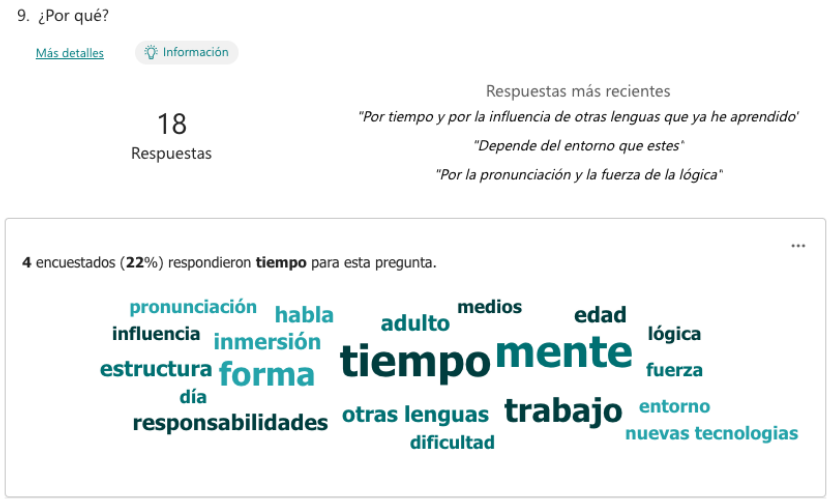
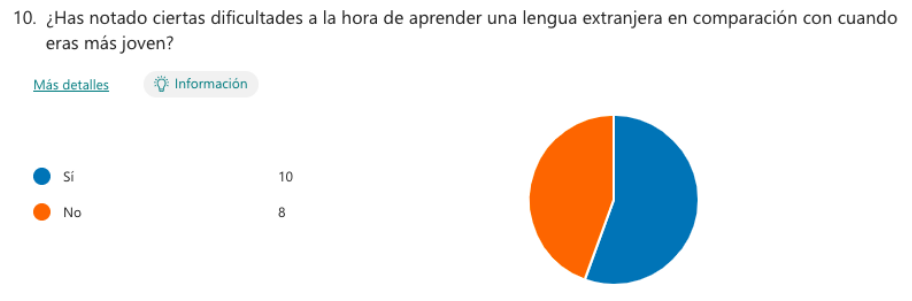


Figure 15. *Asking people if they have noticed certain difficulties when learning a language as an adult in comparison to when they were younger*



Question number 10 above (Figure 15), asked whether participants have noticed difficulties in acquiring a language as an adult in comparison to when they were younger. Again, question 10 and question 11 below are related. On question 10, 10 participants out of 18 affirmed that they find learning a new foreign language more difficult than when they were younger.

Also, these 10 participants on question number 11 below (Figure 16) affirmed that they found it more difficult because of pronunciation and because when they were younger, they understood things faster. Yet, one participant answered that learning a foreign language as a child was more difficult than now because they did not have the basis in grammar and was not able to make connections between languages.

Figure 16. *Asking people which difficulties they have found, if any*

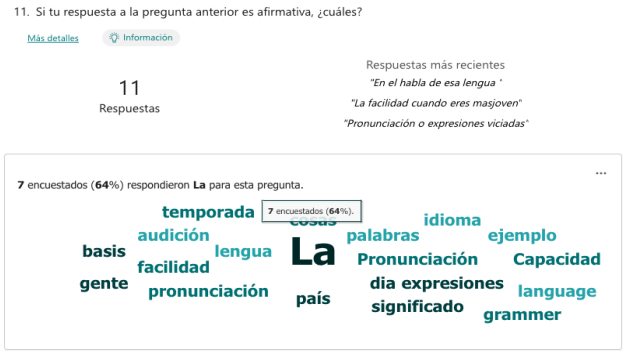
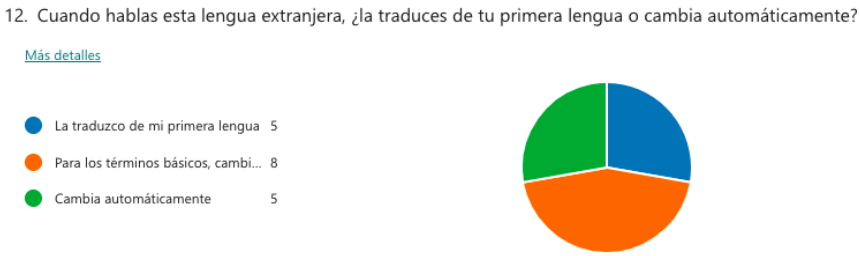


Figure 17. *Asking people if they translate from their first language or change automatically when speaking that language*



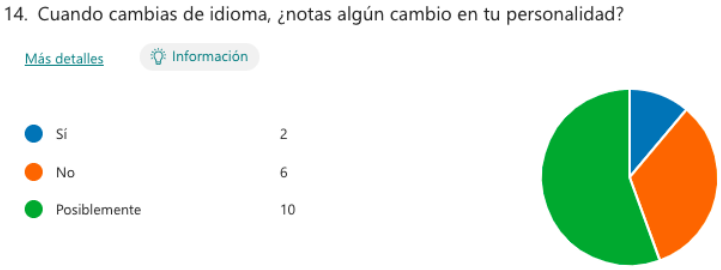
Question number 12 above (Figure 17), asked whether participants translate from their first language or they change automatically to the other language. The 44% of the participants affirm that for basic terms they change automatically but for more complex structures they translate from their first language. Then, five of them, representing the 28% of the graph, affirm

that they translate it from their first language and again, the same number of participants answered that they change languages automatically.

Figure 18. *Asking people whether they have noticed an improvement in concentration while/after learning that language*

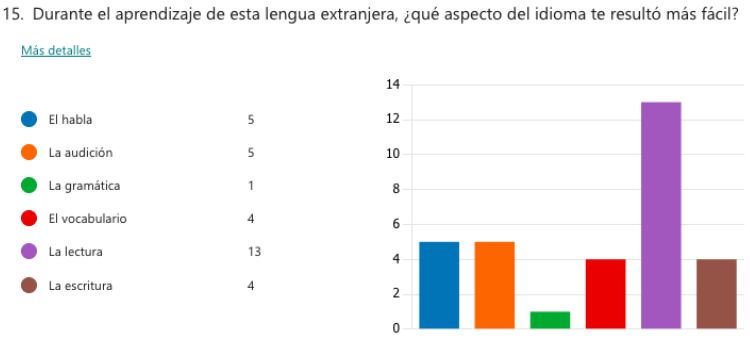
Question number 13 above (Figure 18), asked whether the participants have noticed a notable improvement on concentration after being exposed to the learning of a new language. The 50% of them answered that they have indeed noticed an improvement. Meanwhile, 33% of them negated this question and the resting 17% affirm that they have noticed it but only in some tasks.

Figure 19. *Asking people whether when they change the language, they notice a change in personality*



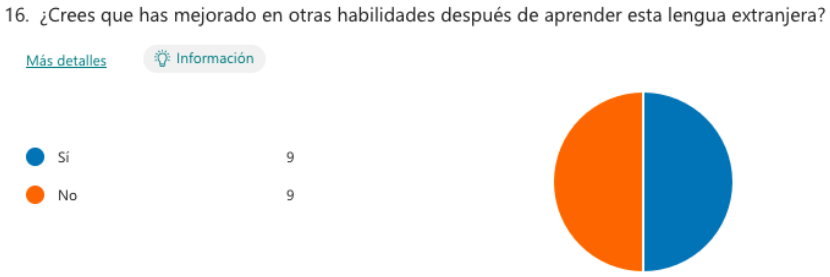
Question number 14 above (Figure 19), asked whether participants notice a change in their personality when changing languages. The 56% of them was not so sure and answered that it probably does. A 33% of the participants negated the question and only two of them agreed that it definitely does.

Figure 20. *Asking people what aspect of the language was easier for them*



Question number 15 above (Figure 20), asked what aspect of the language was easier for the participants when learning that new foreign language. A total of 13 people affirmed that it was the reading part that it was the easier one. Then, five of them answered that it was the speaking and another five that it was the listening. Also, a number of four participants affirmed that it was the vocabulary and another four that it was the writing. Overall, it can be seen that the grammar aspect was what people found most difficult when learning a foreign language.

Figure 21. *Asking people whether they have improved on other abilities*



Question number 16 above (Figure 21), shows whether participants have noticed an improvement in other abilities after learning a new foreign language. The results here are clear, since one 50% have answered “yes” and the other 50% have answered “no”. Question number 17 below (Figure 22) is related to the previous question for those who answered “yes”. It asks in which tasks they consider that they have improved after learning the foreing language. The majority of them affirm that they have improved in the capacity of concentration, in communicating and in better brain agility.

Figure 22. *Asking people in which abilities they have noticed an improvement, if any*

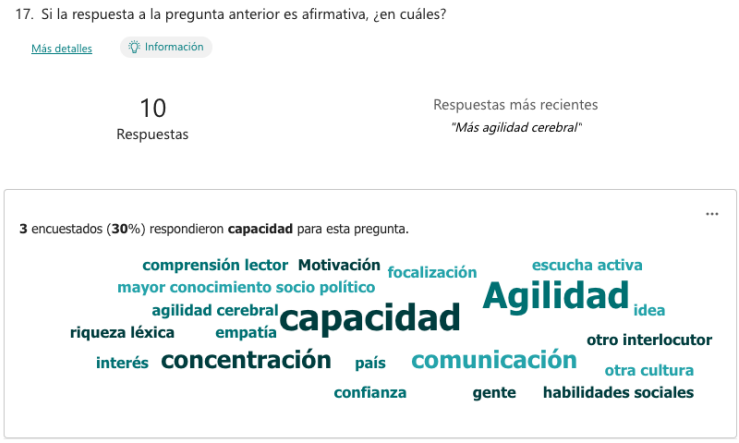
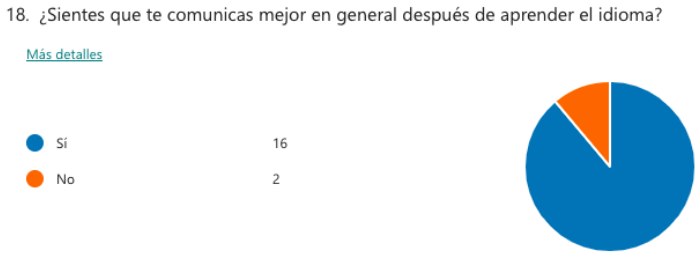
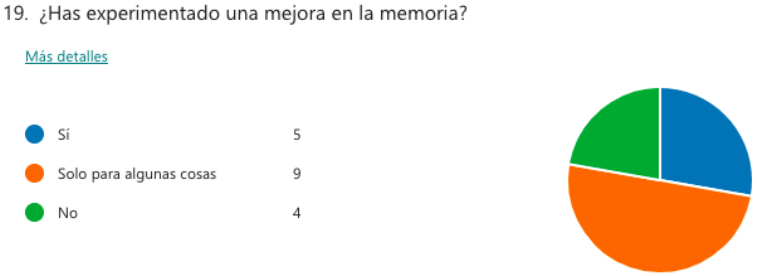


Figure 23. *Asking people if they feel better at communicating*



Question number 18 above (Figure 23), asked whether participants feel that they are better at communicating after learning that certain language. The majority of them, being a total number of 16 participants affirmed that they indeed are better at communicating and only two of them answered that they have not noticed any improvement on their communication.

Figure 24. *Asking people if their memory have improved*



Question number 19 above (Figure 24), asked whether participants think that their memory has improved while/after learning a foreign language. A 50% of them answered that it has but only for some aspects. Meanwhile, other five people answered that it has completely improved and the resting four that it has definitely not.

Figure 25. *Asking people what other aspects of their daily lives have improved*

Lastly in question number 20 above (Figure 25), asked to participants what other aspects of their daily lives have improved after acquiring that foreign language. The majority of them answered that it was concentration, communicating with strangers, working with more abilities and their capacity of communicating when they travel.

4. Discussion

The main research question of this thesis is to know whether learning a foreign language as an adult is actually beneficial for the brain. It is obvious that doing so, will not affect badly but it was necessary to know if it affects notoriously well on them. Taking into consideration the results of the questionnaire, the major findings were that a big percentage of the participants affirmed that learning a new language has helped them with tasks that involve memory and communication, among other things.

When I first started sending the questionnaire and had no responses yet, I expected the participants to give full detail in those questions that had to be written in order to accomplish a better understanding of the situation they are in, and so they did. It can be seen in the individual results that those participants that have not yet acquired a high level of the language they are learning, is because they affirm that they do not have the enough time to do so due to work and family and not because they do not have the capacity to do it. Then, those who affirm that they have not experienced any improvement of memory and/or communication it can be due to the reason that they are still in the first level (A1) of learning a language and because they affirm that the language is not much present in their daily lives. Also, it is clear that among those participants that support that learning a new language as an adult is more difficult than when they were younger, is because they feel the need to translate everything before pronouncing what they actually want to say due to the fear of failing in the attempt.

As mentioned before in this study, it is said that learning a new language decreases the probability of age-related cognitive decline and dementia. Taking this statement into consideration, the participant who was in the age-range of more than 60 years old, affirmed that

learning a new language is difficult for them due to their current capacity of memorization. Nevertheless, this participant affirms that learning a foreign language has helped in tasks like focusing on something and in communication with family and friends and also in memory.

Basing on the theory of the five types of bilinguals previously mentioned, the majority of the participants that answered the questionnaire, can be considered sequential and subordinate bilinguals. The sequential bilinguals, as it is already known, are those that learn a new language after having acquired their first language fully. This pattern can be applied to those participants that speak no more than two languages. Then, the subordinate bilinguals are those who learn a new language from filtering and translating it from their first language. This can also be applied to the participants that always translate from their first language even though having achieved a high level in it.

Quoting again, "the Findings from the Centre for Cognitive Ageing at the University of Edinburgh show that reading, verbal fluency, and intellect all increase when one learns a new language" (see page 13). From that point of view, the majority of the participants, not to say all of them, have affirmed that their capacity to communicate better with other people has improved. This can be due to the previously mentioned "improvement in verbal fluency".

On the other hand, it came to my surprise that an equal percentage of participants affirmed that they think and that they do not think that they have improved at other abilities after having learned that new language. Since throughout this study it is said that learning a new language assures an improvement on other abilities like the ones mentioned (reading comprehension and intelligence in general).

In summary, the findings of the questionnaire affirm that learning a new language as an adult is greatly beneficial for their mental agility, even though it can be more difficult to acquire it in comparison to a younger age. It is left clear that those participants that have not yet reached a high level on the language is because of matters like time and other responsibilities more than because of age itself.

4.1. Limitations of the study

After developing the results and discussion sections, different limitations were found in relation to this study. To have a better insight on the comparison between monolinguals and bilinguals/multilinguals, another questionnaire could have been created directed only to monolinguals, to actually prove that bilinguals can experience more benefits than those who only speak one language. Also, to prove how their current capacity of memory is related to language knowledge.

Another limitation that was presented throughout this study was the inability to demonstrate through fMRI scan how the monolingual brain is different to that of a bilingual/multilingual person and which parts of the brain are activated when learning that new language. If these limitations were carried out successfully, this study could have provided a deeper understanding in how the brain works with language acquisition.

Nevertheless, I am more than satisfied with the points I was able to prove with the methodology I carried out, since I could prove that bilinguals actually present those benefits mentioned previously in the study and also what impact learning a new foreign language had on their daily lives.

5. Conclusions

In the language acquisition area, it is important to know what limitations people have when acquiring a new language in the sense of age range in order to be able to actually learn. Throughout this study it has been proven that adult learners present more difficulties in order to properly acquire a new language since they have more responsibilities than a younger language learner. What has been found is that once they have acquired a new language, their brain offers a lot of benefits in order to avoid natural deterioriation and dementia caused by the old age, such as an improvement in memory, verbal/lexical fluency and communication. In relation to what age range learns faster, it can be said that younger learners have greater ease to acquire a language, not only because of time, but because their brain has not yet been exposed to many different areas of the language. In conclusion, learning a new language, without taking into consideration the age range, will be always beneficial to an individual.

6. References

Abutalebi, J., Canini, M., Della Rosa, P. A., Sheung, L. P., Green, D., & Cormann, G. (2014). Bilingualism protects anterior temporal lobe integrity in aging. *Neurobiology of Aging*, *35*(9), 2126–2133. https://doi.org/10.1016/j.neurobiolaging.2014.03.010

Albalooshi, S. (2021, December 10). The Effects of Second Language Acquisition on the Brain. *Medium*. https://medium.com/swlh/the-effects-of-second-language-acquisition-on-the-brain-c13778b45a

Anderson, J. R., Grundy, J., De Frutos, J., Barker, R., Grady, C. L., & Bialystok, E. (2018). Effects of bilingualism on white matter integrity in older adults. *NeuroImage*, *167*, 143–150. https://doi.org/10.1016/j.neuroimage.2017.11.038

Bak, T. H., Nissan, J., Allerhand, M., & Deary, I. J. (2014). Does bilingualism influence cognitive aging? *Annals of Neurology*, *75*(6), 959–963. https://doi.org/10.1002/ana.24158

Bialystok, E., Craik, F. I. M., Grady, C. L., Chau, W., Ishii, R., Gunji, A., & Pantev, C. (2005). Effect of bilingualism on cognitive control in the Simon task: evidence from MEG. *NeuroImage*, *24*(1), 40–49. https://doi.org/10.1016/j.neuroimage.2004.09.044

Bialystok, E. (2021). Bilingualism: Pathway to Cognitive Reserve. *Trends in Cognitive Sciences*, *25*(5), 355–364. https://doi.org/10.1016/j.tics.2021.02.003

Bibliotecaselles. (2015, October 1). *The benefits of a bilingual brain, por Mia Nacamulli*. Biblioteca Gerardo Sellés Solá. https://bibselles.wordpress.com/2015/10/22/the-benefits-of-a-bilingual-brain-por-mia-nacamulli/

Byers-Heinlein, K., & Lew-Williams, C. (2013). Bilingualism in the Early Years: What the Science Says. *LEARNing landscapes*, *7*(1), 95-112. https://doi.org/10.36510/learnland.v7i1.632

Carlson, S. M., & Meltzoff, A. N. (2008). Bilingual experience and executive functioning in young children. *Developmental Science*, *11*(2), 282–298. https://doi.org/10.1111/j.1467-7687.2008.00675.x

Costa, A., & Sebastián-Gallés, N. (2014). How does the bilingual experience sculpt the brain? *Nature Reviews Neuroscience*, *15*(5), 336–345. https://doi.org/10.1038/nrn3709

Garbin, G., Sanjuán, A., Forn, C., Bustamante, J. M., Rodríguez-Pujadas, A., Belloch, V., Hernández, M., Costa, A., & Ávila, C. (2010). Bridging language and attention: Brain basis of the impact of bilingualism on cognitive control. *NeuroImage*, *53*(4), 1272–1278. https://doi.org/10.1016/j.neuroimage.2010.05.078

Gold, B. T., Kim, C., Caterson, I. D., Kryscio, R. J., & Smith, C. D. (2013). Lifelong Bilingualism Maintains Neural Efficiency for Cognitive Control in Aging. *The Journal of Neuroscience*, *33*(2), 387–396. https://doi.org/10.1523/jneurosci.3837-12.2013

Grady, C. L., Luk, G., Craik, F. I. M., & Bialystok, E. (2015). Brain network activity in monolingual and bilingual older adults. *Neuropsychologia*, *66*, 170–181. https://doi.org/10.1016/j.neuropsychologia.2014.10.042

Higby, E., Kim, J., & Obler, L. K. (2013). Multilingualism and the Brain. *Annual Review of Applied Linguistics*, *33*, 68–101. https://doi.org/10.1017/s0267190513000081

Hong, S. B. (n.d.). *Learning a Foreign Language in Adulthood using Principles of Neuroscience*. https://www.arcjournals.org. https://www.arcjournals.org/journal-of-neuroscience/volume-2-issue-1/3

How Learning a Language Changes Depending on Your Age | Lingvist. (s. f.). Lingvist. https://lingvist.com/blog/how-learning-a-language-changes-depending-on-your-age/

Kim, S. W., Jeon, S. W., Nam, Y., Kim, H. C., Yoo, D., & Moon, M. (2019). Bilingualism for Dementia: Neurological Mechanisms Associated With Functional and Structural Changes in the Brain. *Frontiers in Neuroscience*, *13*. https://doi.org/10.3389/fnins.2019.01224

Knapp, S. (2020). Broca's Area. *Biology Dictionary*. https://biologydictionary.net/brocas-area/

Kuhl, P. K. (2010). Brain Mechanisms in Early Language Acquisition. Neuron, 67, 713-727. - References - Scientific Research Publishing. (n.d.). https://www.scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/ReferencesPapers.aspx?ReferenceID=1275105

Li, P., Legault, J., & Litcofsky, K. A. (2014). Neuroplasticity as a function of second language learning: Anatomical changes in the human brain. *Cortex*, *58*, 301–324. https://doi.org/10.1016/j.cortex.2014.05.001

Ljungberg, J. K., Hansson, P., Andrés, P., Josefsson, M., & Nilsson, L. (2013). A Longitudinal Study of Memory Advantages in Bilinguals. *Plos One*, *8*(9), e73029. https://doi.org/10.1371/journal.pone.0073029

Luk, G., De Sa, E., & Bialystok, E. (2011). Is there a relation between onset age of bilingualism and enhancement of cognitive control? *Bilingualism: Language and Cognition*, *14*(4), 588–595. https://doi.org/10.1017/s1366728911000010

Marian, V. (2012, October 1). *The Cognitive Benefits of Being Bilingual*. PubMed Central (PMC). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3583091/

Morales, J., Calvo, A., & Bialystok, E. (2013). Working memory development in monolingual and bilingual children. *Journal of Experimental Child Psychology*. https://doi.org/10.1016/j.jecp.2012.09.002

MSEd, K. C. (2023). How the Wernicke's Area of the Brain Functions. *Verywell Mind*. https://www.verywellmind.com/wernickes-area-2796017

Neuroanatomy, Gray Matter. (2023, January 1). PubMed. https://pubmed.ncbi.nlm.nih.gov/31990494/

Newport, E. L. (2020). Children and Adults as Language Learners: Rules, Variation, and Maturational Change. *Topics in Cognitive Science*, *12*(1), 153-169. https://doi.org/10.1111/tops.12416

Nichols, E. S., Wild, C. J., Stojanoski, B., Battista, M. E., & Owen, A. M. (2020). Bilingualism Affords No General Cognitive Advantages: A Population Study of Executive Function in 11,000 People. *Psychological Science*, *31*(5), 548–567. https://doi.org/10.1177/0956797620903113

Schweizer, T. A., Ware, J., Fischer, C. E., Craik, F. I. M., & Bialystok, E. (2012). Bilingualism as a contributor to cognitive reserve: Evidence from brain atrophy in Alzheimer's disease. *Cortex*, *48*(8), 991–996. https://doi.org/10.1016/j.cortex.2011.04.009

Smith, D. G. (2018, May 4). *At What Age Does Our Ability to Learn a New Language Like a Native Speaker Disappear?* Scientific American. https://www.scientificamerican.com/article/at-what-age-does-our-ability-to-learn-a-new-language-like-a-native-speaker-disappear/

Appendix A

Table 1. ***Questionnaire Questions***

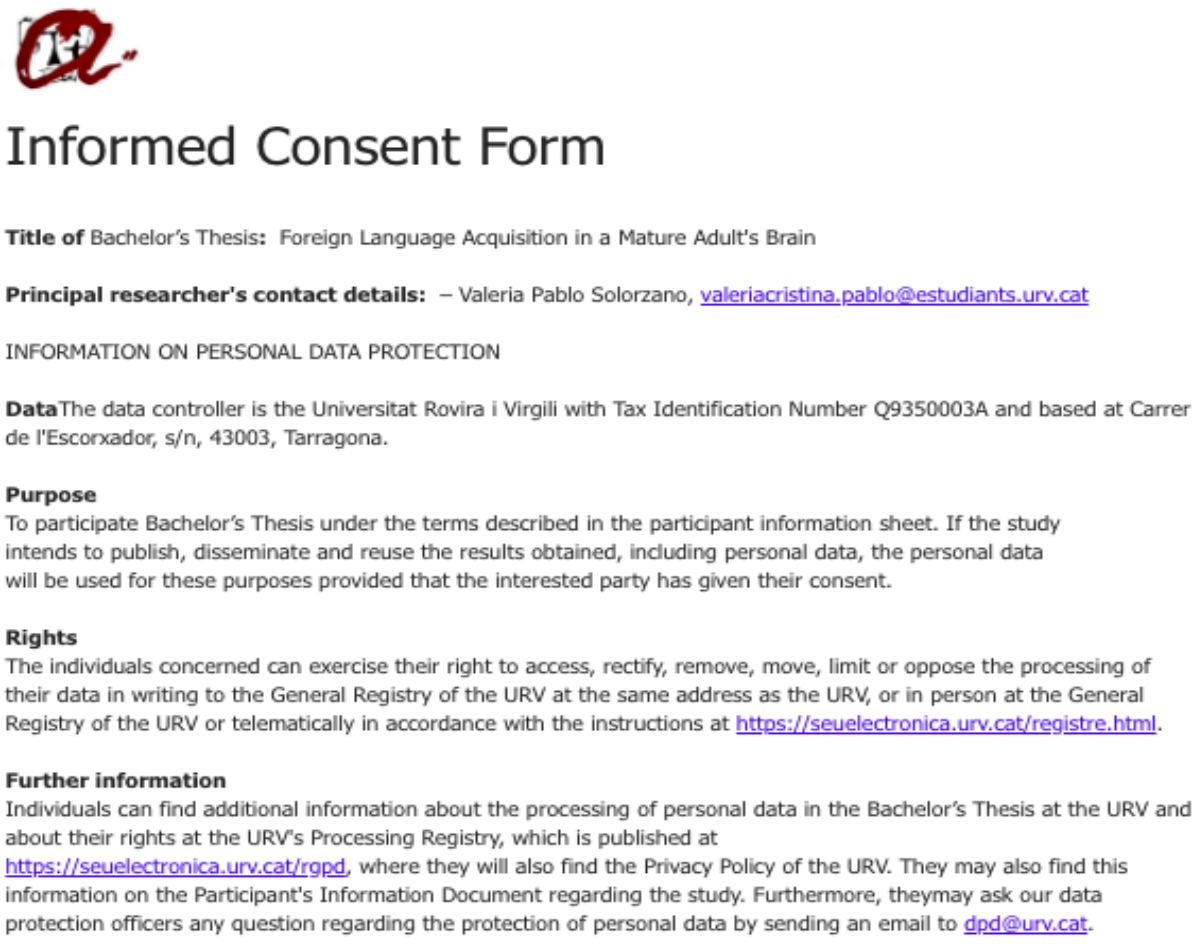
Questionnaire questions	**Translation**
1. ¿ En qué franja de edad te encuentras?	1. What age range are you in?
2. ¿Estás aprendiendo o ya has aprendido una lengua extranjera?	2. Are you learning, or have you already learned a foreign language?
3. ¿Por qué estás aprendiendo o has aprendido una lengua extranjera de adulto?	3. Why are you learning, or have you learned a foreign language as an adult?
4. ¿Qué nivel has alcanzado en este idioma?	4. What level have you reached in this language?
5. Si consideras que dominas el idioma, ¿cuánto tiempo hace que lo dominas?	5. If you consider that you master the language, how long have you mastered it?
6. ¿Esta lengua está muy presente en tu vida cotidiana?	6. Is this language very present in your daily life?
7. ¿Cuántos idiomas hablas?	7. How many languages do you speak?
8. ¿Te resulta difícil aprender una lengua extranjera de adulto?	8. Do you find it difficult to learn a foreign language as an adult?

9. ¿Por qué?	9. Why?
10. ¿Has notado ciertas dificultades a la hora de aprender una lengua extranjera en comparación con cuando eras más joven?	10. Have you noticed certain difficulties when learning a foreign language compared to when you were younger?
11. Si tu respuesta a la pregunta anterior es afirmativa, ¿cuáles?	11. If your answer to the previous question is affirmative, which ones?
12. Cuando hablas esta lengua extranjera, ¿la traduces de tu primera lengua o cambia automáticamente?	12. When you speak this foreign language, do you translate it from your first language, or does it change automatically?
13. ¿Has notado una mejora en tu concentración cuando tienes que hacer algo mientras/después de aprender esta lengua extranjera?	13. Have you noticed an improvement in your concentration when you have to do something while/after learning this foreign language?
14. Cuando cambias de idioma, ¿notas algún cambio en tu personalidad?	14. When you change languages, do you notice any changes in your personality?

15. Durante el aprendizaje de esta lengua extranjera, ¿qué aspecto del idioma te resultó más fácil?	15. While learning this foreign language, what aspect of the language was easiest for you?
16. ¿Crees que has mejorado en otras habilidades después de aprender esta lengua extranjera?	16. Do you think that you have improved in other skills after learning this foreign language?
17. Si la respuesta a la pregunta anterior es afirmativa, ¿en cuáles?	17. If your answer to the previous question is affirmative, in which ones?
18. ¿Sientes que te comunicas mejor en general después de aprender el idioma?	18. Do you feel that you communicate better in general after learning the language?
19. ¿Has experimentado una mejora en la memoria?	19. Have you experienced an improvement on memory?
20. ¿Qué otros aspectos de tu vida diaria han mejorado?	20. What other aspects of your daily life have improved?

Appendix B

Figure 26. *Microsoft Informed Consent Form*



Informed Consent Form

Title of Bachelor's Thesis**:** Foreign Language Acquisition in a Mature Adult's Brain

Principal researcher's contact details: – Valeria Pablo Solorzano, valeriacristina.pablo@estudiants.urv.cat

INFORMATION ON PERSONAL DATA PROTECTION

DataThe data controller is the Universitat Rovira i Virgili with Tax Identification Number Q9350003A and based at Carrer de l'Escorxador, s/n, 43003, Tarragona.

Purpose
To participate Bachelor's Thesis under the terms described in the participant information sheet. If the study intends to publish, disseminate and reuse the results obtained, including personal data, the personal data will be used for these purposes provided that the interested party has given their consent.

Rights
The individuals concerned can exercise their right to access, rectify, remove, move, limit or oppose the processing of their data in writing to the General Registry of the URV at the same address as the URV, or in person at the General Registry of the URV or telematically in accordance with the instructions at https://seuelectronica.urv.cat/registre.html.

Further information
Individuals can find additional information about the processing of personal data in the Bachelor's Thesis at the URV and about their rights at the URV's Processing Registry, which is published at https://seuelectronica.urv.cat/rgpd, where they will also find the Privacy Policy of the URV. They may also find this information on the Participant's Information Document regarding the study. Furthermore, theymay ask our data protection officers any question regarding the protection of personal data by sending an email to dpd@urv.cat.

1. Please enter your name and identity card number. *

Escriba su respuesta

2. - I have read the copy that I have received of the participant information document regarding the study.
- I have been able to ask and have received answers to my personal questions regarding the study and my participation in it.
- I understand that I am participating in this study in accordance with the specifications in the participant information document and in accordance with the answers that I have received to my questions and I understand the risks and benefits that this entails.
- I accept that my participation is voluntary and I freely agree to participate in the study.
- I understand that I can withdraw at any time from participating in the study and that my withdrawal will not affect me negatively in any way.
- Once the research has been completed, the data obtained may be of interest to other related studies. In this regard, the following options are offered: *

◯ NOT TO AUTHORISE the use of the data in other related research projects.

◯ TO AUTHORISE the use of the data in other related research projects.

3. Please indicate the date and your location (city). *

Escriba su respuesta

4. By writing your name in the space below and submitting this form, you agree to participate in this study. *

Escriba su respuesta