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The Effects of Dementia on Language Ability in a Greek-English Bilingual Individual

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Abstract

The objective of this project was to understand better how a neurodegenerative disease can impact speech and language in individuals who speak multiple languages. Using a case study approach, we measured language expression and understanding through production, comprehension, and word retrieval in a participant with dementia who spoke Greek and English. To examine speech and language decline over time, we administered two commonly used language tests (Boston Naming Test and Bilingual Aphasia Test) in both Greek and English at four different times across a span of approximately seven months. With the goal of examining bilingualism in relation to neurodegenerative diseases, such as dementia, we sought to determine the effects of dementia on language abilities for this participant.

Executive Summary

The purpose of this case study was to consider the effects of dementia on expression and comprehension abilities over the progression of a neurodegenerative disease. This included abilities such as naming and repetition responses for expressive skills, and reading and auditory sentence comprehension responses for comprehension skills.

The findings of the expressive language research aims were found to be language and skill specific. In general, for expressive language abilities, the participant produced Greek answers more frequently, but answers were not more correct. For example, we found that the participant produced responses in Greek when the test was administered in English. This suggests that the primary language (Greek) was preferred over the secondary language (English). For the naming responses, the number of "no responses" increased as the disease progressed across time; spontaneously correct responses were not significant meaning that both languages were impacted to a similar degree. The only expressive skill to unexpectedly improve over time was repetition in English.

For comprehension abilities, our findings suggested that comprehension declined across time. The combined measures of pointing identification, simple and semi-complex commands, verbal auditory comprehension, and reading decreased in both Greek and English with time. For reading, this skill in both languages worsened throughout testing and declined unexpectedly faster in Greek, which was the language that reading was mastered in first. The auditory sentence comprehension started low and diminished across the first two data collection points; the personality and behavioral changes observed here highlighted that dementia influences all aspects of a person.

The limitations of this case study include that the data collection only lasted for approximately seven months, and that prior to starting our data collection, the participant was already diagnosed with severe dementia. From here, it is important to note that these findings concerning language expression and comprehension were specific to the single participant of this case study. The study's findings were informative in that the suggested conclusions parallel other studies relating to the field of bilingualism and neurodegenerative diseases.

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Acknowledgements

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Chapter 1

Introduction

It is estimated that approximately 5 million Americans in their mid-60's present with some form of dementia, and is predicted that these numbers will continue to increase as the population ages (U.S Health and Human Services, 2016). The inevitable decline of language and cognitive function associated with dementia is extremely challenging to navigate for anyone facing this diagnosis; however, these challenges may differ somewhat for individuals who speak more than one language. In the United States, approximately 59.5 million people speak multiple languages, and these numbers continue to grow as the global population becomes more diverse and multilingual (U.S Census Bureau, 2013). As these populations rise, understanding the relationship between multilingualism and neurodegenerative disorders will become more and more imperative.

What is dementia?

The human nervous system is made up of two parts—the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS is composed of the brain, and spinal cord and the PNS consists of cranial and spinal nerves. The CNS contains both grey and white matter. Grey matter is made up of neuron cell bodies, whereas white matter consists of nerve cell axons that carry messages from one cell to the next. Dementia is a neurodegenerative disease, meaning that cognitive functions begin to decline due to progressive damage to the nervous system. Although dementia classifies into several subtypes with different underlying physiologies, all individuals with dementia eventually show atrophy of grey matter in the brain.

As the older adult population increases, it is expected that the incidence and prevalence of dementia will increase accordingly. Accurate differential diagnosis is essential to learning more about causes and potential treatments for dementia. Although this syndrome is often referred to generally as “dementia,” there are several different types of dementia, each with its own pathophysiology and disease progression. Persons with dementia progress through stages of neural degeneration and severity of behavioral symptoms; with individuals typically experiencing milder symptoms in the early disease stages and more severe symptoms in later stages. The term “dementia” refers to a syndrome commonly associated with memory loss, decreased problem-solving and critical thinking skills, and difficulty with language. More specifically, some of the most common types of dementia include Alzheimer's Disease (AD), Lewy Body Dementia (LBD), Fronto-Temporal Dementia (FTD), Vascular Dementia (VD), and Parkinsonian Dementia (PD) (Buffington, Lipski, Westfall, 2013).

Cortical dementias are progressive, degenerative, and associated with problems in language, motor coordination, perception, reasoning, problem-solving and learning. The most common type of cortical dementia is Alzheimer's Disease (AD), which affects approximately 11% of adults ages 65 and older and 32% of adults 85 or older (Alzheimer’s Association, 2014). The most distinct features of AD are difficulty with memory and naming. Alarmingly, by 2030, the prevalence of Alzheimer's is predicted to increase by 50% (from 5.1 million in 2010 to 7.7 million in 2030) within the United States. The second most common form of cortical dementia is Lewy Body Dementia, which is characterized by short attention and poor visuospatial abilities and accounts for approximately 20% of all dementia cases. Fronto-Temporal Dementia is the third most common type of cortical dementia and is commonly associated with Primary Progressive Aphasia, a neurodegenerative disorder that manifests as a primary language disorder within the first two years of the disease. FTD onset can occur as early as age 35 and can also be characterized by personality change (Buffington, Lipski, Westfall, 2013).

In contrast to cortical dementia, subcortical dementia can be progressive, static, or reversible and is typically associated with cognitive slowing, emotionality, arousal, and difficulty with attention and prompt processing. The second most common type is Vascular Dementia, which accounts for 10 to 50% of all dementia cases. This dementia tends to surface as cognitive impairments in stroke patients while severity varies across individuals. The second subcortical dementia type is Parkinsonian Dementia, or dementia due that develops in persons with Parkinson's Disease. With PD, symptoms progress slowly and typically occur within the first year of onset of motor symptoms. The incidence of Parkinsonian dementia increases as physical impairment increases within the patient. For all types of dementia, the age of onset, symptoms, and treatments vary; however, the best way to improve the quality of life for all dementia patients involves care by family members (Buffington, Lipski, Westfall, 2013).

Similar to the variances observed in symptom onset and progression for each type of dementia, pathophysiology also differs across dementia types. Despite significant advances in dementia research, the biological causes of dementia are still under investigation. Research findings to date have found that even within the normal aging process, structures called plaques and tangles can develop in the brain. In Alzheimer's Dementia, neurons—the basis for forming memories, thoughts, and feelings—are destroyed, which is partly due to excessive formation of these plaques and tangles in the brain (Alzheimer's Association).

Plaques are chemical proteins known as beta-amyloid clusters that build up between nerve cells. These protein clusters block synapses, the spaces between nerve cells that allow for chemical communication. At the synapse, chemicals neurotransmitters are released from one neuron and bind to the next neuron, which allows for communication to occur. The plaques formed in AD prevent this transmission from happening, resulting in slowed and/or absent communication (Alzheimer’s Association). Tangles, which are made up of twisted tau protein fibers, are also associated with AD. In healthy cells, tau fibers are responsible for maintaining the transport system of cells to receive necessary supplies and nutrients. In dementia, high areas of tau concentration restrict this transport system, which results in cell death.

Plaques and tangles forming in the brain of a person with dementia tend to follow a pattern that affects critical brain areas involved in learning and memory (Alzheimer's Association). As nerve cells die, the brain drastically shrinks in comparison to the healthy aging brain size. The specific anatomical brain changes include a smaller cortex (responsible for thinking, remembering, and planning), a shriveled hippocampus (area of the cortex that creates new memories), and increased ventricle areas (fluid-filled space). When the brain experiences progressive deterioration, the cortex becomes substantially smaller due to the loss of nerve cells. The neurodegenerative disease eventually takes over the individual’s verbal and nonverbal communication abilities as well as personality, which also affects family members.

Even well before symptoms can be detected, plaques and tangles begin to influence brain areas of learning and memory, thinking, and planning. As the stages of dementia progress, memory and other cognitive problems become more severe. In early stages, memory impairment can begin to interfere with social interactions and the individual’s daily routine, which is typically when the person initially becomes diagnosed with dementia. In later dementia stages, the plaques and tangles spread to speech, understanding, and visuospatial areas of the brain. At this point, the person has trouble recognizing family and friends and experiences changes in personality and behavior (Alzheimer's Association).

Regardless of the stage, dementia adversely reshapes the person's cognition, function, behavioral, and psychological aspects of a person. In dementia, cognitive effects refer to changes in memory, language, thinking, and reasoning (Alzheimer's Association II). Some examples of these changes include forgetfulness, losing track of time, becoming lost in familiar places, forgetting names, acting lost at home, experiencing increased difficulty with communication, and needing help with personal care (WHO, 2016). Here, the behavioral changes refer to any relatable actions or emotions of wondering, depression, anxiety, and sleep disturbances (Miller-Keane Dictionary of medicine, nursing, and health, 2003). Families and caregivers of those with dementia find coping with behavioral changes to be most challenging (Alzheimer's Association II). These behavioral changes include a rise in irritability, physical and verbal agitation, emotional distress, delusions, and hallucinations. Watching a loved one's personality change due to a disease can be extremely difficult and painful for family members to endure. Overall, familiar behaviors and capabilities of a person become drastically altered and continue to decline from the progression of the neurodegenerative disease.

Effects of dementia on multilingual populations

In typical speech and language development, frequent and consistent exposure to speech during the early stages of life is critical for attaining language. The age of language acquisition (AoA) is also essential to maximizing language learning. In general, the earlier a child is exposed to a language, the more fluent the child will become in that language. When a child is exposed to multiple languages, this enriched language experience often results in the child being proficient in more than one language, or multilingual. It has been argued that fluency in multiple languages can positively influence language development, learning abilities, and psychological development (Marian, Shook, 2012). Recent research also suggests that multilingualism may provide some protection against cognitive decline associated with neurodegenerative diseases (Klein, Christie, Parkvall, 2016).

One hypothesis as to why the brains of multilingual individuals may be better protected from a neurodegenerative disease is that they tend to have greater overall grey matter volume. One study used magnetic resonance imaging (MRI) to examine differences in grey matter volume across groups of mono and bilingual individuals. Results showed more bilateral grey matter volume in the bilingual participants (Gasquoine, 2016), which is thought to reflect greater cognitive reserve or resilience to neuropathological damage in the brain.

Cognitive reserve is not measured only using brain structure. However, some evidence suggests that brain structure is clinically more relevant than brain function with respect to cognitive reserve (Guzman-Velez, Tranel, 2015). Measuring cognitive reserve involves a combination of methods, typically including grey matter volume (as measured by MRI, or CT) and neurophysiological testing (e.g., memory, visuospatial capabilities, and speed processing). Also, cognitive reserve tends to be positively influenced by higher educational achievement, affluent socioeconomic status, and overall greater intelligence (Guzman-Velez, Tranel, 2015).

Findings from studies of bilingual individuals show that proficiency in multiple languages has a powerful influence on strengthening cognitive reserve (CR), which may result in greater protection against neurodegenerative diseases. A 2007 study conducted by Bialystok and colleagues, (Guzman-Velez, Tranel, 2015, and Bialystok, Craik, Freedman, 2007) examined the onset of dementia in the context of bilingualism. The participants had different dementia diagnoses, but similar cognitive statuses. The bilingual individuals in this study spent most of their lives using both languages equally and regularly. This study found that the bilingual participants showed a 4.1-year delay of dementia symptoms as compared to the monolingual test group, suggesting that being bilingual substantially delays the symptoms associated with dementia.

In another study, Bialystok and colleagues (2004) investigated further by asking two questions: first, if a bilingual advantage is observed in children, is this advantage sustained into adulthood? Second, does bilingualism provide a defense against the cognitive decline associated with normal aging? Three studies included adult participants of varying adults ages (18-85+) who spoke different combinations of languages (English, Tamil, Cantonese, and French). The tasks were similar across all three experiments, including a language questionnaire, the Peabody Picture Vocabulary Test, the Simon Task (an online color correlated stimulus-response compatibility to measure response time) a Sequencing Span Task, and the Cultural Fair Intelligence Test. Overall, bilingual individuals showed faster responses and were less distracted during experimental procedures. These findings suggest that two languages attenuate the age-related decline in the efficiency of inhibitory processing (Bialystok, Craik, Klein, Viswanathan, 2004).

Furthermore, the studies justified the additional benefits of bilingualism, such that working memory leads to better inhibitory control. Since the age-related processing decline was more severe for monolinguals, being fluent in more than one language has the potential to reduce these negative impacts of brain function deterioration as a person ages. This is how bilingual acquisition during childhood is sustained in adulthood. When comparing monolingual adults versus young children, these studies highlight that inhibitory and executive controls within a lifespan rise and then fall. By being bilingual, these three experiments suggest the rise and fall pattern is not nearly as drastic from adult to childhood, and show that cognition is more reserved (Bialystok, Craik, Klein, Viswanathan, 2004).

Changes with age in brain and language processing

The brain undergoes change as part of the normal aging process. These physical changes and their resulting behavioral impacts vary from person to person. As a person ages, the volume and weight of the brain's white matter shrinks at a rate of 5% per decade after the age of 40 (Peters, 2006). This neuronal death and the increased blood pressure within the vasculature system also change the brain during aging. However, brain changes do not occur to the same extent across all persons. Age, gender, neurotransmitters, hormones, and glucose metabolism are few of the many factors contributing towards the variances of these changes (Peters, 2006).

When neurodegenerative diseases are present within an aging person, this serves as another factor to consider when looking at brain changes with age. Research on the brain about neurodegenerative diseases has highlighted the variances between normal and abnormal brain changes. Specific findings include brain shrinkage in the prefrontal cortex and the hippocampus, where both house complex mental activities such as learning, memory, and planning. Changes to neuronal communication is due to white matter loss, where neurotransmitters are affected. A blood flow reduction within the brain's blood vessels exists because arteries narrow down and grow less. Damage to cells due to the highly reactive free radical molecules (typically oxygen or nitrogen that easily combines with molecules because it contains unpaired electrons; this combination damages the cells) and an overall inflammation due to abnormal situations that are occurring in the brain (U.S Department of Health, 2015).

Cognition refers to one's mental state of being able to experience, process, and understand information. The most widely experienced cognitive change that results from these brain changes is memory loss. Four types of memory include an episodic memory, semantic memory, procedural memory, and working memory. The memory types associated with healthy aging include distinct differences in episodic memory (e.g., memories from the first day of work), and semantic memory (e.g., Paris is the capital of France) (Peters, 2006). Aging, white matter changes, neuronal, hormonal, and neurotransmitter changes all need to be considered when pinpointing why such cognitive changes occur.

Communication skills change slightly with age in comparison to the drastic effects of dementia. In healthy aging, communication can be influenced by health, depression, and other aspects of cognitive decline. Thus, language skills that remain relatively stable at first are vocabulary, grammatical judgment, and repetition; with age, comprehension of complex utterances and naming skills decline over time (Yorkston, Bourgeois, Baylor, 2010). For example, many studies show differences in language fluency between young and older adults when asked to name pictures. These pauses within adult speech include filler words such as "um" when reformulating an answer. Another type of language dysfluency that occurs with aging is producing incorrect syllable sounds within a word (i.e., *coffee cot* instead of *coffee pot)*. The slips of the tongue result from the changes occurring within the brain. Of language dysfluencies, the most evident are the tip-of-the-tongue experiences where one is certain of knowing a word but is unable to produce it (Burke, Shafto, 2004). When adults age, their developed language system is impacted due to the aging process. Such difficulties in language retrieval stem from the changes in the brain that happen with age.

Research Questions

The aim of our current study was to investigate patterns of word-retrieval in a Greek-English bilingual individual with dementia and reflect on these patterns in the context of previous findings. More specifically, we wanted to investigate two research aims, each with multiple research questions:

Aim 1: To determine the effects of dementia on expressive language ability.

- Are the primary and secondary languages differentially affected over the progression of the disease?
- How do naming responses change over the progression of the disease?
- How do repetition responses change over the progression of the disease?

Aim 2: To determine the effects of dementia on language comprehension ability.

- Are the primary and secondary languages differentially affected over the progression of the disease?
- How does reading comprehension change over the progression of the disease?
- How does auditory sentence comprehension change over the progression of the disease?

Chapter 2

Methods

This observational case study investigated language production and comprehension in a single Greek-English bilingual participant with dementia. The participant was administered the *Boston Naming Test* (Kaplan, Weintraub, 2001) and select portions of the *Bilingual Aphasia Test* (Paradis, 1987) in both Greek and English. The tests were administered four times over the course of seven months. The Institutional Review Board at Syracuse University determined this study was exempt from further review.

Participant

The single participant in this study was an 88-year-old, female who was diagnosed with severe dementia approximately two years before our first testing session. Although fluent in both Greek and English, Greek was her first language and English was acquired when she was in her early twenties. To our knowledge, we did not have information regarding any significant previous medical conditions.

Data Collection Tools

Stimulus materials consisted of two common language tests, the *Boston Naming Test* (BNT) and the *Bilingual Aphasia Test* (BAT), used for large populations with neurogenic communication disorders. The BNT consists of 60 black and white line drawings. For each item, the participant was asked to provide a label for the picture (e.g., What is this?). If the participant did not give the correct answer within the allowed time limit (20 seconds), the clinician provided specific cues to support the participant's word-finding abilities. For example, stimulus (i.e., semantic) cues provided word descriptions of the picture to help initiate a response (e.g., "a piece of furniture" to describe "bed"), and phonemic cues provided the initial sound of the picture being named (e.g., /bɛ/ for "bed"). If the cues were unhelpful and no answer was provided, then the picture was labeled as no response (NR). A published version of the BNT is not available in Greek, however, an informal translation was completed by the student researcher and accuracy was verified by the student researcher's parents whom are also fluent in Greek. All instructions and cues were provided in the language corresponding to the test administration (e.g., English cues provided when the English version was administered).

The BAT is unique in that it provided a measure of language comprehension and production and has been translated and validated in 58 languages, including Greek. The BAT tests speech comprehension, repetition, expressive language, mental arithmetic, reading, and writing. For the purposes of this study, all subtests were only administered for the first data collection point. Given the length of the test, only subtests were administered that had potential to change over time. For example, if the participant scored very poorly on a particular area (essentially no items correct), it would not be possible to show decline in function for that area. The following BAT subtests were completed across all four collections: auditory pointing with matching, following simple and semi-complex commands, verbal auditory comprehension, and reading comprehension for words and sentences.

Furthermore, the syntactic comprehension subtest was only administered for the first two consecutive data collections. Due to the lengthiness and repetitive language of this test, the participant became very agitated and less attentive to the tasks presented. Upon initial interpretation of data, during these first two data collections, the scores were low enough that the potential to increase success was slim. With this, this auditory sentence syntactic comprehension subtest only was administered during the first and second testing of data collections. The remaining data results from the BAT sufficed for the purpose of this study.

Data Collection Procedures

The BNT and the BAT were administered to the participant four times over the course of seven months by the student researcher: January 2016, March 2016, May 2016, and July 2016. For each period of data collection, the BNT and BAT were administered over the course of two days in both Greek and English. In data collections, all tests were administered in the same order (i.e., Collection A – Day 1: Greek BNT and English BAT. Day 2: English BNT and Greek BAT) across all four collections (A—D) for over two days each. When administering the BAT, the participant was given two 20 minute breaks to help maintain attention and cooperation.

Data Scoring & Analysis Procedures

The student researcher analyzed the data once all four collections were complete with the assistance of the research advisor. To score the data, the student translated the Greek results, and we used a coding system to compare and analyze the participant's responses on both the BNT and BAT. Each response on the BNT was scored for accuracy and error responses were coded using the coding system found in Table 1.

Table 1. Error codes used to score BNT

Code	Definition
ph	Nonword phonemically based paraphasia (e.g., 'trikola' for 'tripod')
ph/v	Real word phonemically based paraphasia (e.g., 'car' for 'cat')
v	Paraphasia semantically related to the target word (e.g., 'music' for 'harp')
v/u	Unrelated verbal paraphasia (e.g., 'eggplant' for 'dominos')
cl	Circumlocution (e.g., 'it's round and bounces' for 'ball')
p	Perseveration (repeated word from previous item)
perc	Perceptual, naming a detail of the picture (e.g., 'water' for picture of a boat in water)
NR	No response within 20 seconds
csc	Code switch correct (wrong language, correct response given in incorrect
csi	language)

For the BAT, responses were scored for accuracy by marking each response as correct, incorrect, or no response. On the multi-step directional tasks, items were scored on a scale of 0-3 to indicate the number of steps completed by the participant. For each subtest, the number of correct responses and percentages correct were calculated.

Following scoring, we performed chi-square goodness of fit tests using an online software tool (Stangroom, 2017) for each of our variables of interest. In order to address the primary research aim to determine the effects of dementia on expressive language ability, we performed the following statistical comparisons for each of our specific research questions:

- **Are the primary and secondary languages differentially affected over the progression of the disease?** To address this question, we compared the number of "no responses" and spontaneously correct responses across the first data collection point (Time 1) and the last data collection (Time 4) from the BNT. We performed one chi-square test for Greek and a second chi-square test for English for both comparisons.

- **How do naming responses change over the progression of the disease?** To address this question, we compared the number of verbal/semantic paraphasia responses across Time 1 and Time 4 for Greek and English version of the BNT.
- **How do repetition responses change over the progression of the disease?** To address this question, we compared the number of correct repetition responses across Time 1 and Time 4 for Greek and English versions of the BAT.

In order to address the primary research aim to determine the effects of dementia on language comprehension ability, we performed the following statistical comparisons for each of our specific research questions:

- **Are the primary and secondary languages differentially affected over the progression of the disease?** To address this question, we compared the number of correct comprehension responses (pointing identification, simple and semi-complex commands, verbal auditory comprehension, and reading) across Time 1 and Time 4 for Greek and English versions of the BAT.
- **How does reading comprehension change over the progression of the disease?** To address this question, we compared the number of correct reading comprehension responses across Time 1 and Time 4 for Greek and English versions of the BAT.
- **How does auditory sentence comprehension change over the progression of the disease?** To address this question, we compared the number of correct auditory comprehension responses across Time 1 and Time 4 for Greek and English versions of the BAT.

Chapter 3

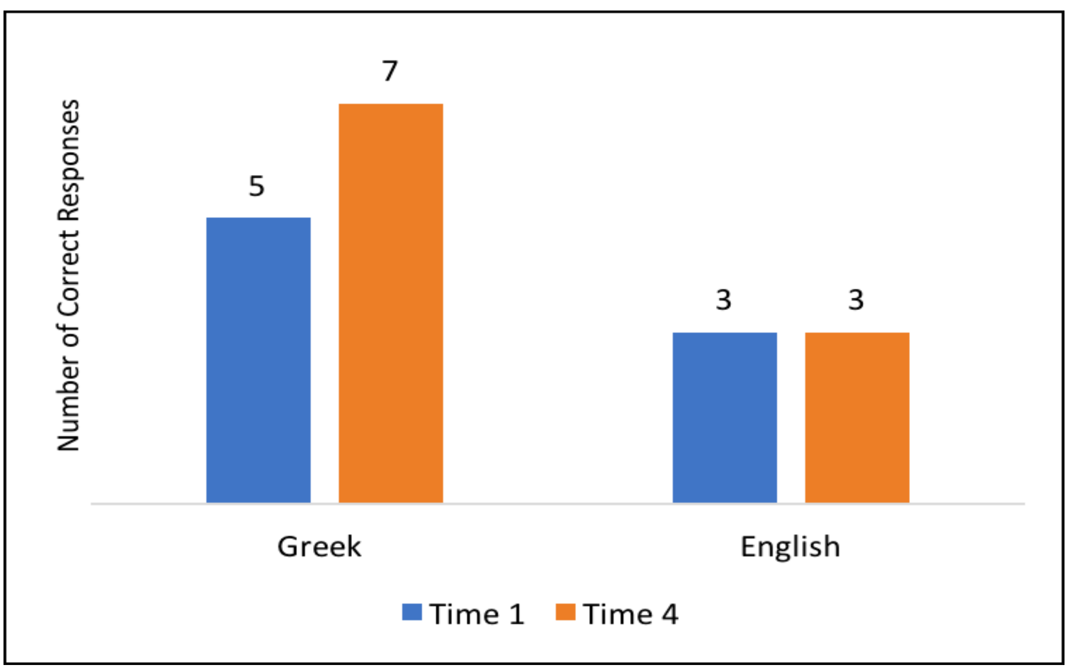
Results

In order to address the primary research aim to determine the effects of dementia on expressive language ability, we report the results of each of our specific research questions and statistical comparisons:

Are the primary and secondary languages differentially affected over the progression of the disease?

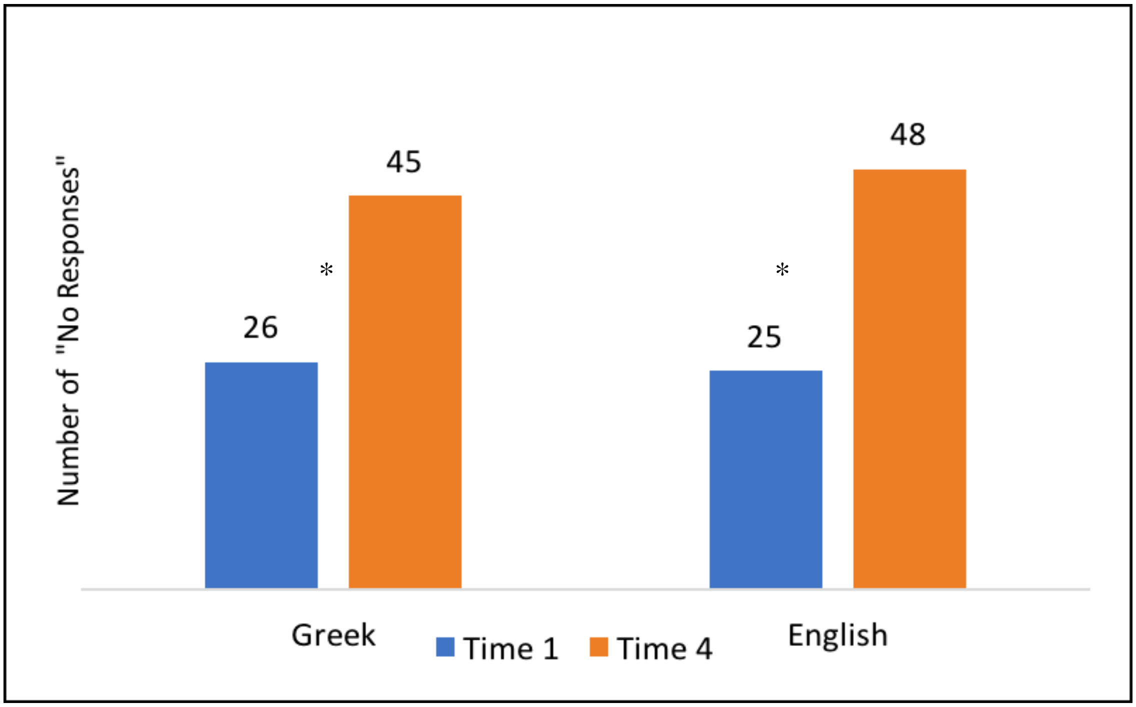
Results of a chi-square goodness of fit test indicated there was not significant difference between the number of spontaneously correct responses on the BNT at the final data collection point (Time 4) as compared to correct responses produced in the first data collection point (Time 1) for either Greek (χ^2 (1, n = 60) = 1.672, p = .642) or English (χ^2 (1, n = 60) = 1.269, p = .736) (see Figure 1). Number of correct responses were very low for both languages and did not change significantly across the seven months between data collection Time 1 and Time 4.

Figure 1.



Results of a chi-square goodness of fit test indicated there was a significant difference between the number of "no responses" on the BNT at the final data collection point (Time 4) as compared to correct responses produced in the first data collection point (Time 1) for both Greek (χ^2 (1, n = 60) = 13.789, $p < .05$) and English (χ^2 (1, n = 60) = 20.894, $p < .05$) (see Figure 2).

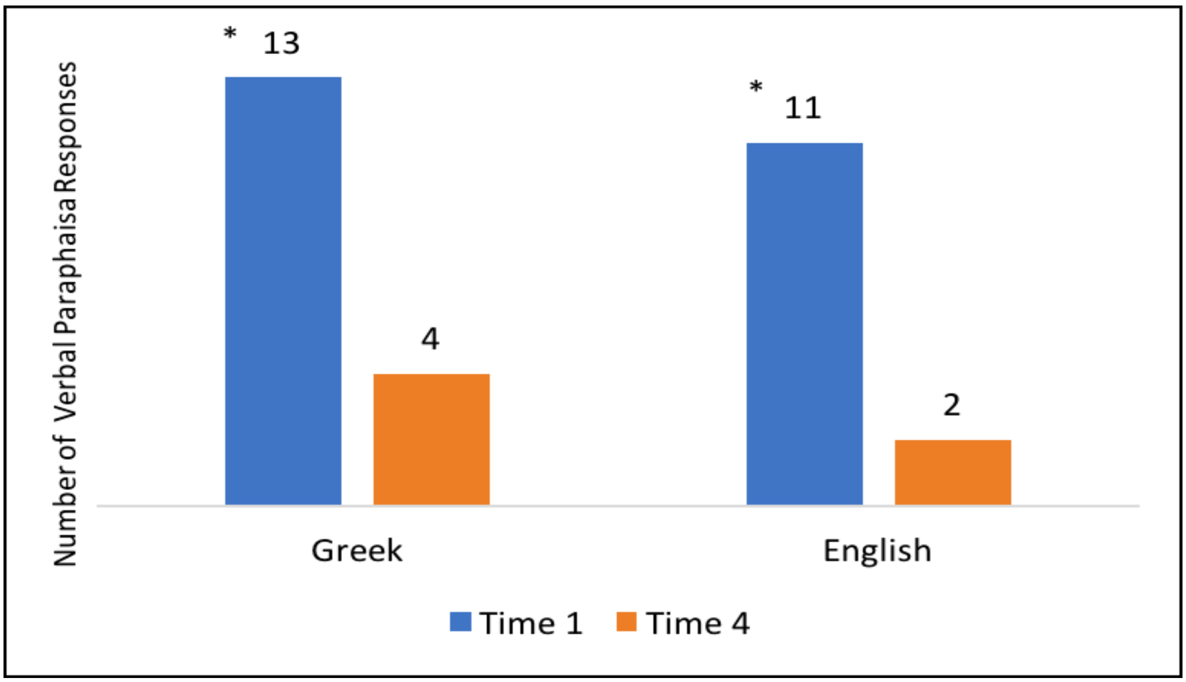
Figure 2.



How do naming responses change over the progression of the disease?

Results of a chi-square goodness of fit test indicated there was a significant difference between the number of verbal/semantic paraphasias on the BNT at the final data collection point (Time 4) as compared to correct responses produced in the first data collection point (Time 1) for both Greek ($\chi^2(1, n = 60) = 12.638$, $p < .05$) and English ($\chi^2(1, n = 60) = 15.129$, $p < .05$) (see Figure 3).

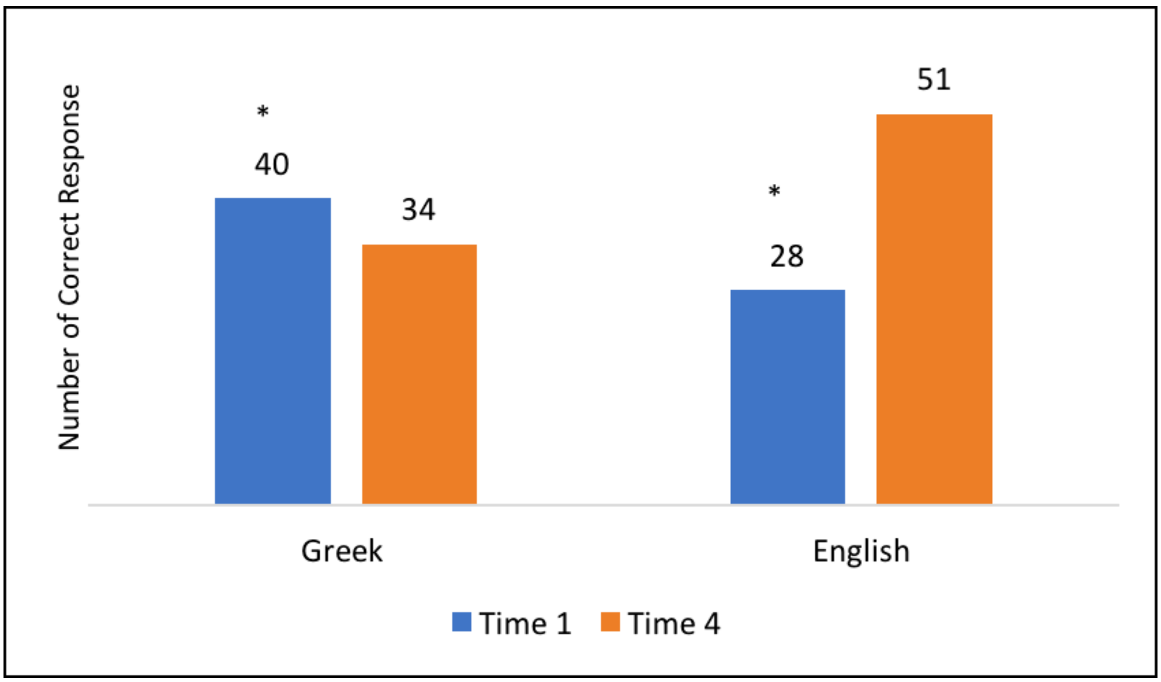
Figure 3.



How do repetition responses change over the progression of the disease?

Results of a chi-square goodness of fit test indicated there was a significant difference between the number of correct repetition responses on the BAT at the final data collection point (Time 4) as compared to correct responses produced in the first data collection point (Time 1) for both Greek (χ^2 (1, n = 59) = 14.064, $p < .05$) and English (χ^2 (1, n = 59) = 24.594, $p < .05$) (see Figure 4). In the Greek version of the test, accuracy declined over time. However, in the English version of the test, accuracy increased over time, contrary to our expectations.

Figure 4.

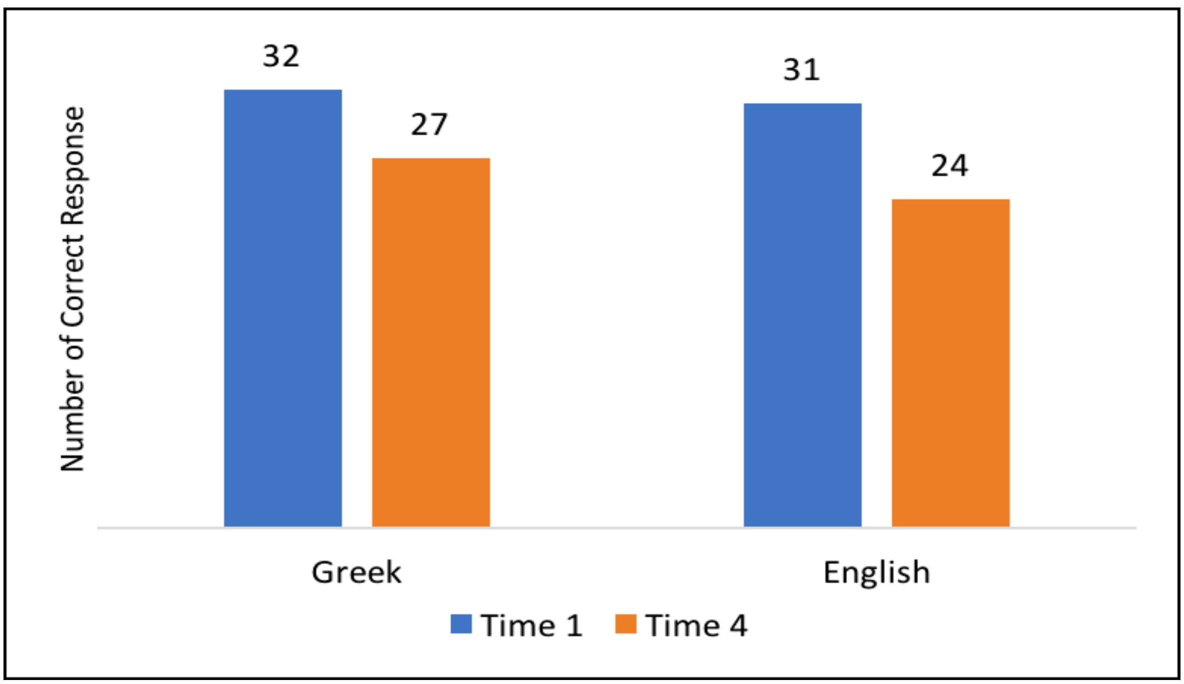


In order to address the primary research aim to determine the effects of dementia on language comprehension ability, we report the results of each of our specific research questions and statistical comparisons:

Are the primary and secondary languages differentially affected over the progression of the disease?

Results of a chi-square goodness of fit test indicated there was not a significant difference between the number of correct comprehension responses on the BAT at the final data collection point (Time 4) as compared to correct responses produced in the first data collection point (Time 1) for both Greek (χ^2 (1, n = 40) = 1.614, p = .024) and English (χ^2 (1, n = 40) = 2.851, p = .091) (see Figure 5).

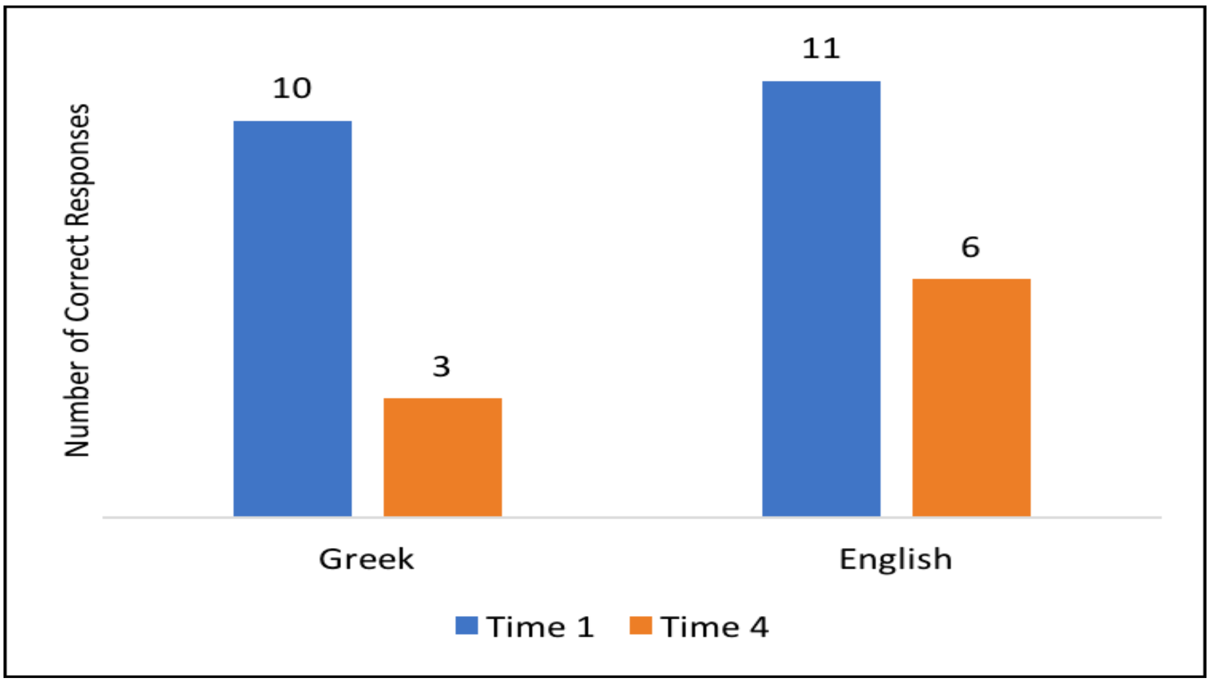
Figure 5.



How does reading comprehension change over the progression of the disease?

Results of a chi-square goodness of fit test indicated there was not a significant difference between the number of correct reading comprehension responses on the BAT at the final data collection point (Time 4) as compared to correct responses produced in the first data collection point (Time 1) for either Greek (χ^2 (1, n = 20) = 5.714, p = .126) or English (χ^2 (1, n = 20) = 3.75, p = .289) (see Figure 6).

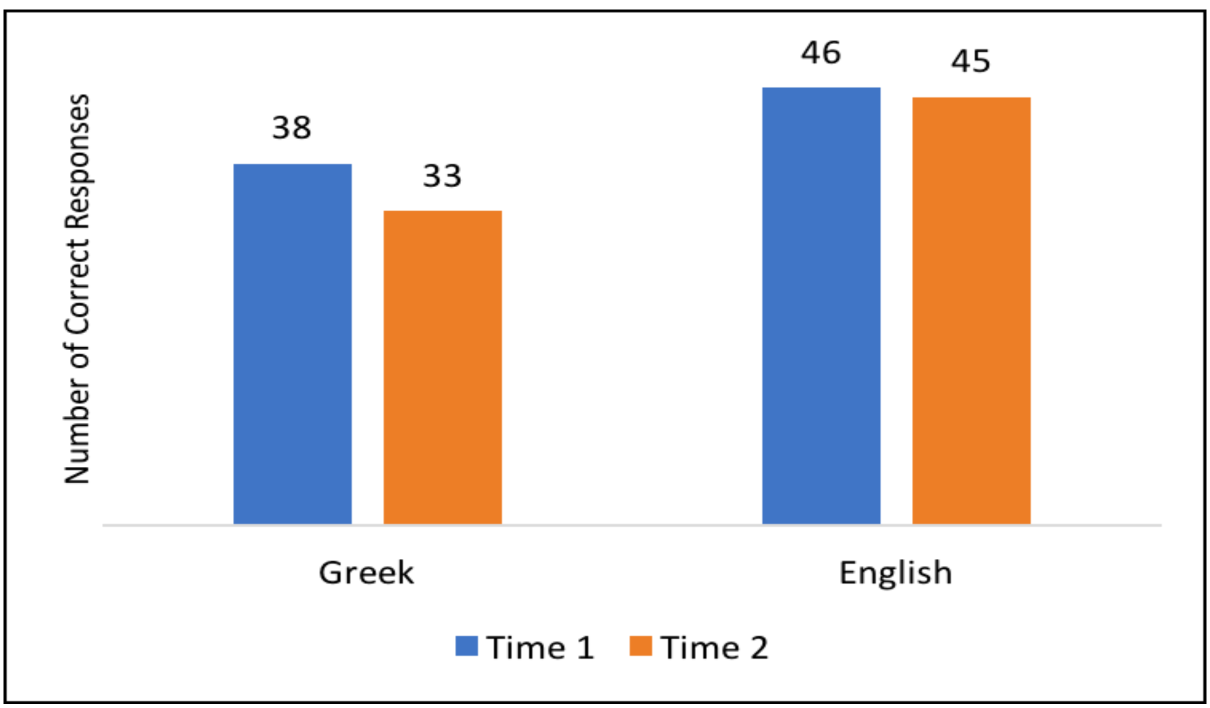
Figure 6.



How does auditory sentence comprehension change over the progression of the disease?

This subtest was administered only during Time 1 and Time 2 due to the length of the test and decreased cooperation from the participant. Results of a chi-square goodness of fit test indicated there was not a significant difference between the number of correct auditory sentence comprehension responses on the BAT at Time 2 as compared to correct responses produced in the first data collection point at Time 1 for either Greek (χ^2(1, n = 86) = 0.599, p = .439) or English (χ^2(1, n = 86) = .0233, p = .878) (see Figure 7). Given the relatively short period of time between data collection points 1 and 2 (3 months), it was expected that we would not observe much change.

Figure 7.



Chapter 4

Discussion

In this case study, we investigated the effects of dementia on expressive and receptive language skills in two different languages (English and Greek). To examine expressive language ability, we measured performance over time on a test of naming (BNT) and on repeating (BAT). To examine receptive language ability, we measured performance over time on several auditory and reading comprehension tasks (BAT). Overall, findings suggested that expression and comprehension were significantly impaired even at the first data collection time point, but still showed an overall decline over the seven months of this study.

Expressive Language Ability

In this study, we sought to determine the effects of dementia on expressive language ability by measuring performance on picture naming and repetition tasks as our participant's disease progressed. Results of our analysis indicated that as the participant's disease progressed, the number of correct responses did not change significantly for either language, however, the total number of "no response" (NR) occurrences increased across both languages. Given the low number of correct responses across all time points, it is evident that dementia has significantly impacted her expressive language ability. Over time, this resulted in a reduced ability to produce any verbal response at all. Interestingly, these same patterns were observed across both languages, suggesting that the participant's dementia affected both languages to a similar degree. The increased number of NR's highlighted the detrimental effects of dementia on language, word-finding abilities, and overall communication. Our findings suggested that regardless of language and/or age of acquisition, dementia affects expressive language abilities at large.

The number of spontaneously correct answers did not decline over time, but remained very low (i.e., 5 and 7 for Greek and 3 and 3 for English; see Figure 1). Given how low this baseline score is, it is expected that with the progression of the disease, these spontaneously correct answers would not decrease significantly (e.g., change from 3 to 1 would unlikely be significant). Although the number of correct responses were higher in Greek than in English across both Time 1 and Time 4, this difference was not significant, suggesting that both languages were affected to approximately the same degree. It should be noted, however, that during testing the participant continued to demonstrate that the L1 (Greek) was her preferred language. With this, it is suggested that dementia has continued to affect naming abilities in both languages, where the participant used English less frequently than Greek, regardless of which language the test was administered in.

From this, we may ask, if Greek was being accessed more often, were her responses in Greek more accurate? To answer this, we considered the number of times that code switching occurred in both languages. Across all the times we administered the BNT in English, the participant inappropriately responded in Greek a total of 65 times (out of 240 possible opportunities). Of the 65 Greek responses, she used the correct lexical label (but in the wrong language) a total of 13 times and used an incorrect lexical label (and also in the wrong language) a total of 52 times. From this, it appears that although she occasionally was able to produce a correct lexical label in her primary language, most of the time she was still unable to produce a correct response. Overall, the participant accessed the wrong language and was still producing incorrect responses for the BNT administered in English. Interestingly, she did not show a similar pattern when administered the BNT in Greek. In other words, when the test was administered in Greek, she tended to respond in Greek. This difference in how the participant responded suggests that she was more comfortable speaking Greek than English, which would be expected given that Greek was her primary language.

Of all error types, the participant most frequently produced verbal/semantic paraphasias; word errors that are related in meaning (e.g., ‘stairs’ produced instead of ‘escalator’, ‘music’ for harp, ‘horse’ for unicorn). When examining the number of verbal/semantic paraphasias over time, surprisingly, the participant actually produced fewer of these errors in the last time point as compared to the first time point. Given the progressive nature of her dementia, we might expect the number of errors to increase, however, we did not observe that pattern. One way to explain this unexpected pattern would be to look to the number of times the participant did not respond on the BNT. This is important because as the responses semantically related to the target word decreased, the number of NR’s increased (see Figure 3). Semantically related answers (e.g., ‘music’ for harp) to the target word were provided at first by the participant, but these answers then changed to “no responses” as the dementia progressed. This continues to show that the participant’s expressive abilities declined with time, and in this case, within both languages.

The additional question of expressive abilities concerns the number of repetition responses. By looking at the BAT repetition subtest, it is first important to note that these skills are not truly comprehensive. This repetition task only requires a basic, superficial level of language processing, meaning that this skill does not involve conceptual, deeper, or critical thinking; repetition does not even require comprehension. Here, scores were low, but the participant demonstrated some level of auditory processing and intact speech production. Figure 4 shows that across time, Greek repetition skills worsened from 40 to 34 correct and improved in English from 28 to 51 correct. Looking closer at these English results, it was the case that for Time 2 and Time 3, the pattern of correct repetition results increased incrementally. Our reasoning for this is that the participant either became familiar with the subtest and/or that she was more alert during this administration.

Considering the participant's expressive abilities, the BNT and BAT findings suggested both the primary and secondary languages were affected over the progression of the disease. Specific expressive abilities regarding naming and repetition responses both worsened with time. Addressing whether the primary and secondary languages were differentially affected as time progressed, both language systems have been influenced to varying extents. The biggest takeaway for language expression includes: “no responses” increased as the disease progressed for both languages, the spontaneously correct responses did not have a significant relationship, meaning although the answers were slightly higher in Greek the participant did not perform better in Greek, and the semantically related answers (verbal paraphasias) that were somewhat correct because the responses were similar in meaning, were then traded-off as no verbal responses at all. The only expressive skill to improve with time was repetition in English. However, due to the nature of the disease, it is likely that this ability will start to decline over time as well.

Receptive Language Ability

The BNT relied heavily on accessing language for expression, whereas the BAT provided more comprehensive language testing. Thus, we sought to determine the effects of dementia on comprehension language ability by measuring performance on reading comprehension and auditory sentence comprehension tasks as our participant’s disease progressed. Results of our analysis indicated that as the dementia progressed, comprehension skills decreased approximately to the same degree across time in both languages.

The comparison used to address this question combined all comprehension measures (pointing identification, following simple and semi-complex commands, verbal auditory sentence comprehension, and reading comprehension) on the BAT from Time 1 and Time 4. Results demonstrated that the number of correct responses declined in both Greek and English (see Figure 5). It is important to note that if the BAT repetition subtest was included in this comprehension measure, it would have drastically increased the overall English scores across time because of how much repetition improved. The reason we did not include repetition here was because these scores were already included as an expressive language test. Also, by not including repetition here, the comprehension abilities are depicted more accurately. Since this was not a significant relationship, comprehension skills in both languages and across all data collections decreased at similar rates over time (see Figure 5).

To further look at this aim, findings from the BAT reading comprehension task suggested that the reading skills declined similarly across both languages due to the relationship not being significant. Reading skills require higher, deeper, and more complicated levels of processing; necessitating the ability to read written cues and process auditory information are critical to be able to read. Within our data, it was expected that reading in Greek would start higher than English, being that it was the primary language, but this was not observed. Reading in both languages started low and declined similarly over time (see Figure 6). A way to explain why the reading scores in Greek were not higher may be due to severity of the dementia prior to our data collection. In this case, dementia still impacted both language systems for reading comprehension abilities.

Considering the participant's comprehension abilities, the auditory sentence comprehension measure of the BAT was another essential contribution to our findings (see

Figure 7). This subtest was challenging for the participant to complete due to its length. In this subtest, the participant was instructed to point to the correct picture following sentences that were read by the student administrator. For example, the participant heard “the boy holds the girl/ the girl holds the boy/ she holds him/ she holds her/ and she holds them," and was required to match the sentence heard to the correct picture. The redundancy of wording within this task was frustrating for the participant and she became increasingly less corporative and less attentive. The participant expressed her frustration through aggressive verbal and gestural remarks in both languages. Because of this reaction, we decided it was not appropriate to re-administer this subtest after these first two data collection time points.

Moreover, upon the initial interpretation of the first two data collections, many of the BAT subtest scores were at most 30% correct and the likelihood of showing any significant improvement or change was low. Thus, we selected to administer only a subset of these subtests for the remaining data collection periods to avoid further frustrating the participant. This also raises awareness regarding the additional implications that dementia asserts on attention, behavior, and personality, on top of cognition and language in both expressive and comprehension abilities.

Interpreting the results, our findings highlighted that all comprehension abilities were affected by the progression of the disease in both languages. Particularly, combined comprehension tasks, reading, and auditory sentence comprehension skills all declined across data collections. Our takeaway here includes: the combined measures of BAT tasks (pointing identification, simple and semi-complex commands, verbal auditory comprehension, and reading) decreased for both languages, reading declined across both languages over time, where it was not expected for the primary language, and the observation of the personality and behavioral changes of increased agitation during the auditory sentence comprehension task were imperative to these findings.

Chapter 5

Conclusion

Overall, we found that both expressive and receptive language skills declined over time and that these changes were fairly consistent across primary and secondary languages. Although we did observe some unexpected patterns (e.g., repetition improved in English), our observations were mostly similar with the declining language other studies have reported. Additionally, the behavioral and personality changes observed signify and coincide with other reported studies as well. This suggests that not only does dementia change comprehension and expressive abilities, but also behavior, attention, and personality; ultimately impacting all aspects of a person and his or her family.

To this end, questioning how the primary and secondary languages have been affected by dementia concerning expressive and comprehension skills was informative for this case study. The expressive skills of naming and repetition and the comprehension skills of reading and auditory sentence comprehension demonstrated that across time, both languages (Greek and English) were detrimentally influenced with the presence of a neurodegenerative disease. The findings from this case study are specific to our single participant, but the results and findings from this data appropriately contribute to the field of bilingualism and dementia.

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