VERB PRODUCTION AND COMPREHENSION IN DEMENTIA:
A VERB ARGUMENT STRUCTURE APPROACH

By

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ABBREVIATIONS

AD   Alzheimer's Disease

BAI   Beck Anxiety Inventory

BDI   Beck Depression Inventory

CDR   Clinical Dementia Rating

FTD   Frontotemporal Dementia

FRSSD   Functional Rating Scale of Symptoms of Dementia

FUCAS   Functional Cognitive Assessment Scale

GDS   Geriatric Depression Scale

MCI   Mild Cognitive Impairment

MMSE   Mini Mental State Examination

MoCA   Montreal Cognitive Assessment

NP   Noun Phrase

PP   Prepositional Phrase

RAVT   Rey Auditory-Verbal Learning Test

RBMT   Rivermead Behavioural Memory Test

ROCT   Rey Ostereith Complex Figure Test

SD   Semantic Dementia

SPMT   Sentence-Picture Matching Task

WM   Working Memory

WMC   Working Memory Capacity

ABSTRACT

This thesis investigates the difficulty of people with Mild Cognitive Impairment (MCI), mild and moderate Alzheimer's Disease (AD) in the production and comprehension of psychological verbs, where thematic realization requires both the canonical and non-canonical realization of arguments. Assignment of θ-roles has been proven to be problematic for people with AD. However, for people with MCI even less studies have examined this issue. Moreover, the assignment of thematic roles in constructions with psychological verbs contains an advanced level of difficulty for people with AD (Manouilidou et al., 2009). Hence, this issue remains open for investigation cross-linguistically and for the different levels of (pre-) dementia. In this study, I aim to examine whether there is a deficit in the mapping of syntactic and semantic representations in psych verbs in people with MCI and AD. Another goal of this study is to investigate whether the linguistic abilities in the aforementioned issue decrease as the disease progresses. Furthermore, I take into account a factor stemming from our everyday lives, the frequency of occurrence of the examined verbs, aiming to investigate whether the language performance is influenced by frequency. Moreover, considering the decline of the cognitive abilities in people with MCI and AD, I address the issue of Working Memory influencing the assignment of the thematic roles. To this aim, a Working Memory test with both the digit forward and backwards tasks (Wechsler, 1981) was administered and two Sentence-Picture Matchings Tasks (SPMTs) were used, one to assess the comprehension and one for the production of thematic-roles. These tasks included verbs that follow the canonical thematic hierarchy (employing the *Agent* and *Theme* roles) and verbs that follow non-canonical thematic hierarchy, that is psychological verbs with primary role the *Experiencer,* assigning the *Theme* before the *Experiencer* at the surface level of the sentence. Greek-speaking people with MCI (N=20), mild AD (N=16), moderate AD (N=11) and healthy individuals (N=47) participated in the tasks resulting to confirmation of previous findings. The deficit in the thematic role assignment is evident; with greater difficulty in sentences involving the *Experiencer* thematic role. The findings of this study suggest that there is gradual degradation of assigning thematic roles as the disease progresses, especially in sentences involving psychological verbs. Frequency influences the overall linguistic performance in the tasks in a significant level. Lastly, results regarding the influence of Working Memory show that the linguistic performance is not strongly affected by the function of the Working Memory.

1

INTRODUCTION

1.1 Introduction

The purpose of this study is to shed light to the linguistic deficit in populations with dementia, and more specifically with Mild Cognitive Impairment and Alzheimer's Disease; by examining the assignment of thematic roles (θ-roles) in sentences including psychological verbs.

The interest in types of dementia and its precursor is due to the relevance of the disease in present-day world society (Caloi, 2017). 47 millions of people worldwide were reported by the World Alzheimer Report in 2016 (Prince et al. 2016) as people with a type of dementia. This number surpasses the number of inhabitants in Spain, a whole country, and it is expected, according to the report, to triplicate until 2050 reaching the number of 131 million. The impact of this disease is observed not only at the social level but also in the economic one, because of their need for assistance in their everyday life. What is worrying, is the lack of total treatment once the disease has started. Despite the efforts of medicine, dementia is problematic in terms of its diagnosis, because a variety of cognitive abilities is assessed in combination with medical workup. Language is a crucial component in the procedure of diagnosis as linguistic deficits are among the first symptoms that accompany the onset of the disease. Therefore, further investigation of linguistic impairment is a necessity in order to enhance the diagnostic techniques used nowadays.

Furthermore, the lack of efficient drugs for the treatment of the disease has necessitated the development of training programs for maintenance and increase of the cognitive abilities in people with either Mild Cognitive Impairment or a type of dementia. Exercises aiming to improve linguistic abilities are often included in such programs.

Unfortunately, linguistic impairment in (pre-) dementia has so far failed to be effectively assessed. For instance, o lot of research has been conducted regarding anomia, but not as much for sentence processing and especially focusing on verb processing at sentence level. Therefore, research upon sentence processing is needed as

a step towards better understanding the linguistic deficit detected in populations with dementia and moreover, as a diagnostic tool and domain of training in the future.

The content of this study pertains to the difficulty of people with Mild Cognitive Impairment and Alzheimer's Disease in the production and comprehension of psychological verbs, where thematic realization requires the non-canonical realization of arguments.

1.2 Overview of the study

After a brief introduction to the reasons leading to this study, Chapter 2 presents essential information on the neurodegenerative nature of dementia and its impact on a person's everyday life, cognitive and language abilities. Chapter 3 contains the theoretical framework in which the linguistic deficit in population with dementia will be assessed in this study. The interface between syntax and semantics, thematic relations, canonicity in thematic hierarchy and psychological verbs in Greek are analyzed leading to the experimental design and research questions. The overview of the previous studies in Chapter 4 sets the basis of the current study and enrichment of data interpretation. In Chapter 5, the research questions of this study are presented as well as the characteristics of the participants, the material used for the current experimental purposes and the procedure followed for the realization of the experimental tasks. Following, in Chapter 6 the results from the experimental tasks are statistically analyzed and further summarized and discussed in Chapter 7 aiming to answer this study's research questions.

2
CLINICAL PROFILE OF MILD COGNITIVE IMPAIRMENT AND DEMENTIA

Epidemiological studies report that the average life expectancy of the elderly is constantly increasing (Poptsi et al., 2010) and indicate that the proportion of older people worldwide has increased from 8% in 1950 to 10% in 2000. This increase is expected to continue with the elderly population reaching 21% of the total population on earth in 2050 (United Nations, 2002). As life expectancy increases, brain

dysfunctions and syndromes such as dementia and Mild Cognitive Impairment (MCI) tend to form an epidemic and constantly arouse the interest of the scientific community (Petersen et al., 2001).

Dementia is a chronic or persistent syndrome with the deterioration of the mental processes caused by brain disease or injury and is characterized by memory disorders, personality changes, and diminished reasoning. Consequently, domains of everyday life are affected, such as orientation, comprehension, calculation, learning capacity, language, and judgement and, furthermore, individuals with dementia face difficulties with emotional and behavioral control (WHO), but they remain conscious.

Mild Cognitive Impairment is a neurodegenerative condition that usually appears before the onset of dementia and is considered by many scientists to precede different types of dementia. It is characterized by subjective memory complaints, and by an objective lack of episodic and working memory. Moreover, complex daily activities are not affected at all or only slightly affected in dementia whereas individuals with MCI do not experience any other cognitive impairment (Petersen et al., 2001). The deficit in cognitive functions observed in people with MCI is not severe enough to meet the criteria for dementia (Viesser et al., 2002).

Dementia is revealed differently depending on each individual's medical and neuropsychological history and profile, but there are strong similarities regarding the demonstration of abnormal brain changes. According to the Alzheimer's Association, the main types of dementia are:

    (1) Alzheimer's disease (60-80% of cases)

    (2) Lewy Body dementia (5-10% of cases)

    (3) Vascular Dementia (5-10% of cases)

    (4) Frontotemporal Dementia (5-10% of cases)

    (5) Parkinson's Disease

    (6) Huntington's Disease

    (7) Mixed Dementia (involving brain changes of multiple types of dementia at the same time).

The diagnosis of dementia or MCI is made by neuropsychological testing and medical workup. Neuropsychological testing involves written or computerized tests that provide a detailed evaluation of specific thinking skills such as judgment, planning, problem-solving, reasoning, language abilities and memory. According to the Alzheimer's

, the medical workup for a neurodegenerative condition includes exhaustive medical history, where the physician documents current symptoms, previous illnesses and medical conditions, as well as any family history of memory difficulties or dementia. Then neurological examination is conducted in order to examine the function of the brain, more specifically the function of nerves and reflexes, movement, coordination, balance and senses in combination with laboratory tests and neuroimaging. The neuropsychological examination includes an assessment of independent function and daily activities, which focuses on any changes in an individual's regular level of their day-to-day function. Information from a family member or trusted friend regarding the daily life of the individual examined is needed in order to provide an additional perspective on how daily activities and functions may have changed. Additionally, an evaluation of the cognitive functions is conducted using brief tests designed to assess memory, planning, orientation, judgment, ability to learn and understand visual information and other important mental skills. Last but not least, an assessment regarding the state of the mood is used in order to identify depression due to the fact that depression is a medical illness showing difficulties with memory, similar to the ones a person with MCI or dementia may demonstrate, often misleading to a dementia diagnosis.

The aim of this chapter is to present the main characteristics of the clinical profile of MCI and dementia of Alzheimer's type and the level of impairment of an individual's with MCI or AD cognitive skills focusing on the domain of language. The first section (1.1) analyzes MCI, its general picture and the impairment of language abilities. The second section (1.2) delves into Alzheimer's Disease by analyzing the stages of this type of dementia and the consequences its progression has on an individual's everyday life and language capacity.

2.1 Mild Cognitive Impairment

Mild Cognitive Impairment is a condition in which an individual demonstrates minor difficulties with cognition which can be placed between that of healthy ageing individuals and people with dementia (Winblad et al., 2004), meaning that an individual shows a decline in some mental abilities such as memory and thinking. The symptoms presented are not serious enough to intervene in everyday life, and this is why they are

not designated as dementia. According to the Alzheimer's Society, 5 to 20% of people older than 65 present MCI. Although MCI is not a type of dementia, a person with MCI is more prone to progress to dementia, especially Alzheimer's disease (Cambell et al. (2013)), at a rate of 10-15% per year (Petersen & Bennett, 2005). The cause of this condition is still undefined, as well as prevention and treatment are, but according to the Alzheimer's Association MCI risk factors are mostly connected with aging, genetic hereditary cause for any type of dementia and cardiovascular conditions leading to related diseases, just like in cases of dementia.

As mentioned previously, diagnosing an individual with MCI necessitates significant clinical judgement, as Grundman et al. (2004) mentioned in their study, and an extensive and broad clinical assessment, which includes clinical examination (Smailagic et al., 2015) with observation, neuroimaging, blood test, neuropsychological testing and cerebrospinal fluid tests in order to define if the person has MCI due to Alzheimer's (Alzheimer's Association). According to Morris et al. (2001), the most important symptoms for an MCI diagnosis are: (1) evidential memory impairment, (2) level of maintenance of general cognitive and functional abilities and (3) lack of a diagnosed type of dementia.

The research focused on individuals with MCI is limited, especially regarding their language abilities. Most of the studies in the linguistic field include people with MCI while examining a type of dementia, mainly Alzheimer's Disease. According to Faroqi-Shah et al. (2020), some studies have examined speech production in neurodegenerative syndromes regarding fluency, word retrieval and syntax. As Taler & Phillips (2008) mention in their study, MCI individuals may face language decline early in the progression course of this neurodegenerative condition, but this is not a certain indication due to the heterogeneity of their cognitive impairment. Nevertheless, research in MCI shows that lexical-semantic impairment is typically detected in primary stages (Choi, 2009; Taler & Phillips, 2008). Although there is high probability of declined idea density (Roark et al., 2011), in a study on fluency people with MCI demonstrated mainly the same performance with healthy ageing individuals (Roark et al., 2011). In the lexical-semantic level individuals with MCI present deficits relatively early on from the onset of the neurodegenerative condition (Faroqi-Shah et al., 2020), while in the syntactic level, they perform similarly with both healthy ageing people and individuals with AD. Although the research is limited, it is evident that the most

affected domain of language is the one coping with the lexical-semantics, in which persons with MCI demonstrate milder deficits than people with AD but impairment in spontaneous speech is as severe as in individuals with AD following the same pattern of errors (semantic paraphasias, circumlocutions among others) (Faroqi-Shah et al., 2020; Drummond et al., 2015; Roark et al., 2011; Jarrold et al., 2010; Choi, 2009; Taler & Phillips, 2008). Apart from semantics, few indications of impairment are detected in fluency, phonology and syntax, without forming a clear picture of specifically identified deficits in this case of the neurodegenerative condition.

2.2 Alzheimer's Disease

Alzheimer's disease (AD) is recognized as the prototypical type of dementia (Deutsch et al., 2016) and defined as an age-related, non-reversible neurodegenerative disease of the central nervous system that develops gradually. As Burns & Iliffe (2009) mentioned in their clinical review article, this type of dementia is a fatal disease, accounting for 60% to 70% of dementia cases, while it is rarely seen in people under 65.

AD is a disease with a progressive course and its beginning is difficult to define, although pathologically there are strong hallmarks regarding the functions of the brain correlated with it. According to the Alzheimer's Association, there are three main stages that a person with AD goes through. The initial stage AD is characterized by gradual loss of memory and decline of other cognitive functions of the brain, but the person with AD is autonomous and capable of functioning independently. In most cases, individuals with AD do not realize the small decline they experience, but family and close friends probably notice these slight changes, such as problem in remembering names when meeting new people or finding the right word/ name, losing/misplacing objects, or difficulty with planning and organizing. In the middle stage, symptoms are more distinct and steadily lead to changes in the behavioral and personality state of the patient. At this point, an individual with AD often confuses words, shows frustrated or angry behavior and reacts erratically. The symptoms may vary from case to case, but generally, the brain damage and the slow loss of nerve cells they experience, makes it difficult to communicate their thoughts and be effective in their everyday life, to remember events and personal details of their lives or to choose the suitable pieces of clothing according to the season or the occasion. Additionally, there is a decline in

cognitive abilities such as decision-making and language skills, and recognizing family and friends. As the disease progresses, a severe loss of mental function is expected leading to the continuous breakdown of the connections between certain neurons in the brain. In the final stage, individuals with AD demonstrate great difficulty in following and participating in a conversation, comprehending what is happening in their environment and, eventually, in using their physical abilities and generally using their motor skills. At some point at this stage, even swallowing gets harder or disappears as an ability. Personality changes are severe reaching levels of behavioral disorders (aggression, apathy, hyperactivity) and the AD individual entirely depends on a caregiver, while their immune system gets weak with a strong sensitivity to infections, such as pneumonia. However, interacting with other people is crucially beneficial in maintaining a stable psychological state of calmness and reassurance and deeply comforting.

In normal aging, the brain typically shrinks to some degree but it is remarkable that it does not lose neurons in large numbers. On the contrary, in AD neuron damage is widespread. Neurons stop functioning, connections with other neurons are lost and eventually a large number of neurons die due to the fact that this disease disrupts processes crucial to neurons and their networks, including communication, metabolism, memory, learning and repair. In terms of brain areas, damage appears firstly in the hippocampus and later on in its connected structures. The hippocampus is the first affected area, which is significantly essential for the recovery of memories, mostly recent ones rather than ones from long ago, and for the formation of new memories[1]. According to Feinberg & Farah (1997), in the early stages of AD medial temporal lobe structures are affected, leaving the basal ganglia and frontal cortex, particularly Broca's area and motor regions, relatively intact. As the disease progresses, other brain areas are gradually damaged, such as the amygdala, which is located deep and enclosed within the temporal lobes. The amygdala is responsible for the performance of memory and plays a significant role in decision-making and emotional responses. So, a person with AD can often easily recall emotional aspects of a situation or a fact, while may face difficulties to recall the actual content of it. According to the Alzheimer's Society, the effect of the worsening of the disease is noticeably located in the cortex, an area that

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[1] Alzheimer's Association
Stages: https://www.alz.org/alzheimers-dementia/stages

shrivels up. This area controls and participates in information processing, thinking, planning, remembering and language processing, therefore memory function is severely impaired. At this point, an AD patient demonstrates significant difficulty to retrieve both new and old memories. Additionally, the left hemisphere of the brain is responsible for the semantic memory and language processing as well. Damage to this area is illustrated as great difficulty in finding the right word, when describing a situation or an object. According to McKee et al. (2006), the visual system is affected due to the damage in the temporal lobes. More specifically, the associative visual cortex is one of the early loci that AD has an effect on, but its impairment is clinically apparent at a more advanced stage, when disturbances regarding memory and attention are fully established. In many cases, the damage may spread to the right parietal lobe (Mandell & Green, 2011), an area responsible for the visuospatial ability. Therefore, a person with AD demonstrates environmental and geographical disorientation and difficulty in navigation. This combination of damaged areas leads a person with AD to show serious problems in recognition, both of common objects and familiar faces. This difficulty is defined as 'visual agnosia' (Mandell & Green, 2011: 23).

Nevertheless, many abilities remain intact, especially those acquired in the first decades of life. Procedural memories are stored in the deepest structures of the brain, therefore the skills relying on them (such as dancing, playing a musical instrument) are mostly unaffected in comparison with the overall impaired picture of the brain. These skills remain mostly intact the longest.

As mentioned previously, language abilities are affected early on in AD. According to Szatloczki et al. (2015), evolutionary and isolated language impairment is very often a strong clinical marker that a patient suffers from AD, which can be proven by pathological examination. According to Mandell & Green (2011), the decline in language abilities follows the same path of progression as that of memory. The difference is that memory is significantly affected throughout the stages of the disease. When it reaches the final stage, there is overall loss of memory, even though, according to Stavrakaki (2005), facets of procedural memory may remain intact, while deficits regarding declarative memory are severe. Language does not involve a global impairment, although both the input, which involves auditory perception, processing and comprehension, and the output, which involves the production and delivery of speech in oral and written form, are impaired. In the initial stage, naming and word-

finding difficulties are evident and language abilities are much affected by the engagement of the patient into conversations. Nouns and verbs tend to be omitted and replaced by abstract words such as "it/thing/this", meaning that the content of speech and words starts to disappear from the accessible lexicon of a person with AD. According to Mandell & Green (2011), as the disease progresses, people with AD demonstrate severe anomic features related with the input of language they can process and tend to repeat sentences and words with great success. In other words, they experience the echolalia phenomenon (Cruz, 2010), the meaningless repetition of sentences, words or phrases soon after their instance. Additionally, individuals with AD experience difficulty with speech bearing an emotional tone, both when they need to recognize it in the communication with others and when they need to express something emotional by charging their speech accordingly (Allender & Kazniak, 1989; Kaprinis, 2003). The diminishing of the cognitive abilities of a person with AD as the disease is worsening leads gradually to dysarthria and stuttering (Cummings & Benson, 1992).

3
THEORETICAL FRAMEWORK

3.1 Introduction

This chapter presents the theoretical framework, upon which the experimental design and the research questions of this study are based. The theory of *Government and Bidding,* proposed by Chomsky (Chomsky, 1982; 1986a; 1993) which was later revised in the framework of *The Minimalist Program* (1995), is the basis on which the thematic relations between the constituents of sentences with psychological verbs as predicates are discussed. Thematic roles (henceforth θ-roles) bear important semantic information stored in the *Lexicon.* According to Theophanopoulou-Kontou (2002), Syntax perceives the *Lexicon* as a list of words (or lemmas) of a language. Every word or lemma bears essential information about how it functions semantically and syntactically and therefore, the information constitutes the roadmap for the grammatical formation of phrase-markers during the processing of sentences in a language. The content of the Lexicon is the stepping stone for the syntax and semantics interface, but at the same time there are general lexical rules according to which the relation between syntactic

structure and thematic relations are immediately interfacing to produce and process a sentence.

Aiming to illustrate how θ-roles of psychological verbs in Greek are realized in the deep and surface structure in the following sections I adopt their main schema from Theophanopoulou-Kontou's (2002) interpretation of Government and Binding Theory in the tradition of transformational grammar. In the following sections, the cooperation of the Lexicon and θ-roles is demonstrated (section 3.1) in order to illustrate the interface of the semantic relations and the syntactic structure when θ-roles are assigned in the constituents of a sentence (section 3.2). Moreover, the workings of thematic relations are presented (section 3.3) prior to the formulation of the notion of *canonicity* in argument realization (section 3.4) aiming to explain how the experimental material of this study, which involves the assignment of θ-roles in psychological verbs in Greek (section 3.5), was created.

3.2 The Lexicon and Θ-Roles

In order to form sentences, the information that the Lexicon includes needs to be processed by the interface of semantics and syntax. As Manouilidou et al. (2009) highlight, a sentence involves semantic participants that need to be realized into argument positions by having the syntactic and thematic properties of verbs interacting. According to the *Projection Principle* (Chomsky 1988:29), the syntactic representation of a sentence, sourced in the Lexicon, undergoes limitations regarding subcategorization in different levels:

"Representations at each syntactic level (i.e., LF, and D- and S-structure) are projected from the lexicon, in that they observe the subcategorization properties of lexical items."

According to Theophanopoulou-Kontou (2002) and Terzi (2015), this means that in all representations of a sentence, the framework of subcategorization regarding the heads of lexical items is preserved due to the existence of traces. Traces denote how the lexical items move and which are their in situ places, while they demonstrate the heads of the moving items via creating the relative chains.

Except from other kind of limitations, that a sentence or a word may suffer, there are some restrictions regarding the semantic information that a sentence or a word may bear. According to the transformational grammar that Chomsky proposed in 1965, there are some *selectional restrictions* that refer to the semantic and syntactic features of a word.

Selectional restrictions are influencing the lexical features of a word, meaning that deviations of these features are determined depending on the level of the sentence's acceptance. As a consequence, the formation of thematic roles' assignment is affected.

3.3 Syntactic Structure and Thematic Structure

Thematic roles expressed by the arguments of the predicate are mapped to the Lexicon (thematic grid) and they are related with the syntactic complements of every predicate. Every predicate is stored in the *Lexicon* bearing certain information regarding the features of the syntactic category it belongs to, the restrictions of its subcategorization and the restrictions of the semantic-syntactic frame that it is found in. Moreover, every predicate can assign a specific number of thematic roles constituting the *thematic grid* (Stowell, 1981) or *argument structure* (Williams, 1981). The *thematic grid* or *argument structure* includes a list of thematic roles, which does not follow a certain configuration, but nonetheless denotes their arguments in accordance with the semantic and syntactic features of the predicate. This can be illustrated in the following examples:

(8) σπρώχνω ['sproχno] (push) :

Argument structure: [Agent, Patient]

(9) πείθω ['piθo] (convince):

Argument structure: [Agent, Theme, Patient]

(10) ζωγραφίζω [zogra'fizo] (paint)

Argument structure: [Agent, Theme]

(11) τοποθετώ [topoθe'to] (place):

Argument structure: [Agent, Theme, Locative]

The thematic roles of the predicate have to be realized in specific syntactic categories that constitute the syntactic structure (frame of subcategorization) (Terzi, 2015). The relation between the thematic role and the syntactic structure obtains on the basis of the *lexical realization rules* that refer to every realization of a thematic role and its limitations (Dowty, 1989). Meanwhile, there is an important distribution of this relation in internal and external arguments of the predicate, where the internal arguments refers to the grammatical object and the external to the grammatical subject (Rothstein, 2004).

3.4 Thematic Relations

The structure of the theory of the thematic relations, which constitute an essential part of the theory of grammar, is directly involved with the analysis of a sentence through the framework of *Predicate Logic*. Therefore, the semantic structure of a sentence (*Proposition*) can be analyzed in the following constituents: the arguments and the predicate, which defines the relations between the arguments. For example:

(12)   John pushed Peter.

In the sentence (13) the constituents of the predicate 'pushed' and its two arguments 'John' and 'Peter' are apparent. According to Kitis (2012), if we represent the predicate 'pushed' as Σ and the arguments as α and β, then the semantic structure of the sentence can be illustrated as:

(13) $\Sigma (\alpha, \beta)$

In that case the predicate requires two arguments due to its meaning. In many cases, only one argument is required, such as:

(14) He left.

which can be illustrated in terms of semantics as:

(15) A (k)

where A = 'left' and k = 'he'.

An analysis based on *Predicate Logic* (such as examples (12) & (14)) involves the assignment of the thematic roles. The thematic roles are defined as the syntactic structures that illustrate the position of the related argument in the argument structure of the verb they are linked with (Boland et al., 1995). In other words, they encode the relation between the verb (or as mentioned above 'the predicate') and its arguments. It is important to mention at this point, that a noun may only carry one θ-role and that only arguments bear θ-roles (*Θ-criterion* by Chomsky 1986b: 184). The assignment of the θ-roles depends on the semantic features of the word in the process of defining its syntactic position. More specifically, the semantic properties of the word are the ones responsible for the number of arguments that will be assigned and for defining their relationship.

In addition, every argument is not just another Noun Phrase (NP). On the contrary, every NP plays a different role in the event expressed by the predicate. Consequently, many different thematic roles exist, such as the *agent*, *patient/theme*, *experiencer*, *causer*, *goal*, *instrument* etc. According to its semantic properties, every predicate chooses the suitable θ-roles that its arguments express. In the end, the arguments become representatives of the predicate's thematic roles.

Before the development of the Government and Binding Theory (GB) by Chomsky in the 1980s, many linguistics have worked on the complements of the verbs: Gruber (1965) in his PhD dissertation "Studies in lexical relations", Fillmore (1968) in his article "The Case for Case" and Jackendoff (1972) in the book "Semantic Interpretation in Generative Grammar". Mark Baker (1988) was the one that introduced the thematic roles into the GB theory by formulating the Uniformity of Theta Assignment Hypothesis (or UTAH).

Up until now, many linguists have worked on the thematic roles and their differentiation. What is more, there is a disagreement upon a number of them and not all accept and support the same thematic roles, as Rissman & Majid (2019) review in their article and Kasper (2008) analyses in his MA Thesis. Nevertheless, many researchers (Grimshaw,1990; Gruber, 1965; Jackendoff, 1972, 1990;

Theophanopoulou-Kontou, 2002; Terzi, 2015; Radford, 1997; Koeneman and Zeijlstra 2017; among others) report that there is a range of some widely accepted roles:

(16) (a) **Agent**: denotes the entity that volitionally initiates an action, which the predicate conveys. For example:

John$_{AGENT}$ chased the cat.

(b) **Patient/Theme**: denotes the person or thing that undergoes/receives the effect/result of an action expressed by the predicate. For example:

The storm destroyed the house$_{THEME}$.

(c) **Experiencer**: denotes the person, who experiences an emotion/ psychological state. For example:

Mary$_{EXPERIENCER}$ cried the whole evening.

(d) **Benefactive**: denotes the entity that receives the benefits of an action. For example:

George bought flowers for Helen$_{BENEFACTIVE}$.

(e) **Instrument**: denotes the instrument or tool that is used in order to fulfil an action. For example:

Mary cut the apple into pieces with a knife$_{INSTRUMENT}$.

(f) **Locative**: denotes the place where someone/ something is or the action of the verb takes place. For example:

John is working in Amsterdam$_{LOCATIVE}$.

(g) **Goal**: denotes the entity that moves towards the direction of the action verb. For example:

Roberta brought the book to her sister$_{GOAL}$.

(h) **Source**: denotes the entity/point from which motion begins. For example:

As long as the climber saw the snake, he distanced himself from

itSOURCE.

According to the GBT, the thematic roles evoked by the predicate (or else the thematic grid) are assigned to positions in the level of deep structure. According to Philippaki-Warbuton (1992: 212) "as long as these positions are shown in the surface structure with the form of traces, it is possible for the thematic grid to be expressed directly from the level of the surface structure".

The thematic grid corresponding to the predicate reveals the relation between sentences with different voice, active-passive, something that we can understand intuitively. For example:

(17) (a) Ο   αστακός   έβρασε.

The lobster-M.SG.NOM. boil-PAST.3SG.ACT.

'The water boiled.'

(b)Η   Μαρία   έβρασε   τον

The   Maria-F.SG.NOM.   boil-PAST.3SG.ACT.   the

αστακό.

 lobster-M.SG.ACC.

'Maria boiled the water.'

In the sentences of example (17) it is demonstrated that the θ-role (*Theme*) of the word "astakos" (lobster) remains the same in both sentences despite the different syntactic structure (Subject-Object). This realization is in accordance with our intuition. Additionally, this example elucidates the different function that the words 'astakos' and 'Maria' have in the sentences (17a) and (17b) accordingly, while they keep the same syntactic function (grammatical subject).

Therefore, by referring to the thematic relation expressed by the predicate, the differences regarding the level of acceptance (grammatical/ungrammatical or acceptable, unacceptable) become more apparent between sentences that demonstrate the same syntactic structure. These differentiations are described better and more

systematically by using lexical criteria. Among lexical criteria that have been studied (e.g. Gruber, 1965, Jackendoff 1972) there are some that refer to the structure of passive and reflexive sentences. According to Jackendoff (1972:4), there are limitations when thematic roles of a predicate are expressed via a passive (or a reflexive) structure. Consider, for example, the sentences Jackendoff (1972, p. 44) uses:

(18)*two hundred pounds are weighted by Bill.

(19) The car was hit by John.

Jackendoff (1972) supports that there is differentiation regarding the level of acceptance because of the *thematic hierarchy* established on the basis of the hierarchical order of the θ-roles. More specifically, he proposes a hierarchical order where the *Agent* is the first and the *Theme* is the last:

(20) Agent>locative, source, goal>theme

and he formulates the principle of thematic hierarchy (22) for the passive sentences

(21) "The argument of a verb bearing the highest-ranked semantic role is its subject."

(22) "The [by phrase] has to be higher than the surface subject in the thematic hierarchy".

Hierarchy is defined with direction from left to the right in order for the θ-role of *Agent* to have a higher position than the *Theme.* Therefore, sentence (19) is grammatical because the [by phrase] 'by John', which depicts the *Agent,* is positioned higher in the thematic hierarchy than the grammatical subject 'car' (*Theme*). On the contrary, the [by phrase] in sentence (18) does not denote the *Agent,* but it denotes the *Theme* according to the features of the verb 'weight' and is therefore positioned lower in the hierarchy than the grammatical subject. Consequently, there is a violation of thematic hierarchy.

3.5 Canonicity in thematic relations

As mentioned above, thematic hierarchy illustrates the mapping between thematic roles and grammatical relations or in other words between the semantic representations and syntax. The mapping is happening between the thematic role hierarchy (e.g. Agent>Patient) and the syntactic hierarchy (e.g. Subject>Object) proceeding from left to right aiming to assign the thematic role to the first unfilled syntactic position.

The first to formulate an ordered list for thematic roles aiming to explain the subject selection was Fillmore (1968). Many followed proposing multiple kinds of thematic hierarchies leading to general agreements, but at the same time to differentiations. As in the case of the thematic roles, there is diversity of thematic hierarchies, as the collections from Levin and Rappaport (1995) and Manoulidiou et al. (2009) demonstrate:

(23) Fillmore (1968): Agent > Instrument> Obj

Jackendoff (1972): Agent, Goal/Source/Locative > Theme

Givón (1984): Agent > Dative/Benefactor > Patient > Locative > Instrument

Carrier-Duncan (1985): Agent > Theme > Goal/Source/Locative

Belletti & Rizzi (1988): Agent>Experiencer>Theme

Larson (1988): Agent > Theme > Goal

Baker (1989): Agent > Instrument > Theme/Patient > Goal/Locative

Bresnan & Kanerva (1989): Agent> Benefactor > Experiencer > Instrument> Theme/Patient>Locative

Grimshaw (1990): Agent > Experiencer > Goal/Source/Locative > Theme

Van Valin (1990): Agent > Effector > Experiencer > Locative > Theme > Patient

Speas (1990): Agent > Experiencer > Theme > Goal/Source/Locative > Manner/Time

Jackendoff (1990): Actor > Patient/Benefactor> Theme > Goal/Source/Locative

It is important to highlight that the hierarchies proposed above stem from different approaches and points of view, so the differences are apparent. For a more detailed

presentation of the versions of the Thematic Hierarchy, see the study by Rappaport-Hovav & Levin (2007).

For the purposes of this study, I am focusing on proposals including the roles of the Experiencer and the Theme, which are the thematic roles used for examining the processing of psychological verbs. Belletti & Rizzi (1988), Grimshaw (1990), Bresnan & Kareva (1989), Van Vallin (1990) and Speas (1990) are the ones proposing hierarchies involving the θ-roles in interest. In all proposals, the Experiencer is placed higher than the Theme role, which leads to the generalization that the Experiencer is hierarchized higher than the Theme.

Taking into account the variation of hierarchies, it can be observed that the *Agent* is ranked higher than any other θ-role, meaning that the subject position is occupied by the *Agent* whenever there is an *Agent* in a sentence. This is better depicted in the frame of the notion of *canonicity in argument realization* (Manouilidou et al., 2009). More specifically, in a *canonical* thematic hierarchy, the most prominent position is occupied by the θ-role of *Agent*, but when the *Agent* is absent, there are two possible argument realizations. According to Thompson & Lee (2009) and Manouilidou et al. (2009), the first possible argument realization involves the θ-role after the *Agent* in the hierarchy presented in the sentence in the position of the subject. This type of argument realization is made in accordance with the thematic hierarchy, although it is different from the *Agent*-first realization demonstrated in the hierarchies presented in (24). The term *atypical* will be used from now on for denoting this type of argument realization (Manouilidou et al., 2009). The second possible argument realization refers to instances where the thematic hierarchy is different from the argument realization that actually happens, which is known as *non-canonical* argument realization. Psychological verbs constitute a suitable illustration of both of these kind of deviations with a high level of difficulty, because the Subject-*Experiencer* verbs illustrating the type of *atypical* canonical argument realization and the Object-*Experiencer* verbs showing the *non-canonical* constitute complex structures in terms of processing when compared with *Agent* verbs (Thompson et al., 2009; Manouilidou et al., 2009). Before elaborating more on the complexity of the deviations from canonical argument realization, it is essential to demonstrate how psychological verbs in Greek are assigning their thematic roles.

3.6 Psychological Verbs in Greek

As Kalamida (2015) mentions, psychological verbs (or psych verbs) are defined as verbs that denote a psychological state or an emotion. According to Belletti & Rizzi (1988), the argument structure of psych verbs consists of the thematic roles of the *Theme* and the *Experiencer*. Despite the fact that the θ-role of the *Experiencer* is always present in the argument structure of psychological verbs, at the same time it is capable of interchanging its syntactic structure in accordance with the syntactic position of the Experiencer's realization. (Kalamida, 2010).

Belleti and Rizzi's (1988) analysis divides the Italian verbs into three main categories: (1) Object Experiencer, (2) Subject Experiencer and (3) *piacere* verbs. This analysis has been widely used in the determination of psych verbs classes cross-linguistically. For example, it has been employed by Marin and McNally (2011) for Spanish, Arad (1996, 1998a,b, 2002) for Hebrew and Anagnostopoulou (1996, 1999) for Greek.

Other studies aiming to provide an analysis of the syntactic properties of the psych verbs in Greek have been conducted by Tantos (2005) with an approach on pragmatic aspects, Kordoni (2001) and Alexiadou & Iordachioaia (2014) with a semantic approach and Kalamida (2015, 2019). The last one proposes a new analysis of Greek psych verbs based on the alternation between Subject and Object-Experiencer focusing on the aspectual ambiguity that these verbs demonstrate when there is an object Experiencer structure.

More specifically, Kalamida (2019) attempts a classification of Greek psychological verbs into two main categories: (1) Psych Verbs that alternate their syntactic structure from Subject-*Experiencer* to Object-*Experiencer* (e.g. *tromazo* 'frighten' - *tromazo* 'be frightened', *eknevrizo* 'irritate' - *eknevrizome* 'be irritated') and (2) Psych Verbs that have one stable syntactic structure, the Subject-*Experiencer* structure, (e.g. *apolamvano* 'enjoy', *erotevome* 'fall in love'). Moreover, these verbs formulate a Subject-*Experiencer* structure and an Object-*Experiencer* structure with no change in their voice morphology (example (24)). For instance:

(24) a. O thórivos   trómakse   to peðí.

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the noise-M.SG.NOM   scare-PST.3SG.ACT the child-N.SG.ACC.

'The noise scared the child.'

b. To peðí   trómakse   apo/me ton thórivo.

the child-N.SG.NOM. scare-PST.3SG.ACT by/with the noise-M.SG.ACC.

'The child was scared by/with the noise.'

(25) a. Afti i kathisterisi   eknevrise   ti Maria.

this the delay-F.SG.NOM irritat-PST.3SG.ACT the Maria-F.SG.ACC

'This delay irritated Mary.'

b. I Maria   eknevristike   me afti tin

the Maria-F.SG.NOM irritate-PST.3SG.PASS with this the

kathisterisi.

delay-F.SG.ACC.

'Mary was irritated by this delay.'

(26) a. To ðiaɣónizma   áŋxose   ton mathití.

the test-N.SG.NOM. stress-PST.3SG.ACT the student-M.SG.ACC.

'The test stressed the student.'

b. O mathitís   aŋxóthike   me to diagónisma.

the student-M.SG.NOM stress-PST.3SG.PASS with the test-N.SG.ACC.

'The student got stressed with the test.'

As demonstrated in the examples above adopted by Kalamida (2019), there is a change in voice morphology (example (25)), apart from the different syntactic structure, which requires a prepositional phrase in the position of the Object. This means that some psych verbs form two different syntactic structures while they change their voice morphology from active to non-active and vice versa. Kalamida (2019) concludes that for verbs alternating their syntactic structure from Object-*Experiencer* to Subject-*Experiencer* there are certain factors enriching the proposal made by Alexiadou & Iordâchioaia

(2014) that there is strong influence to the syntactic behavior of Greek psych verbs by the verb features expressing aspect.

Kordoni (2001) analyses the constructions of Experiencer-Subject psych verbs and supports that Modern Greek discriminates three classes of psych verb constructions using the examples below (2001: 203).

Subject-*Experiencer* psych verbs constructions, which include verbs like *'miso'* (hate), '*agapo'* (love) or *'*latrevo*'* (adore). These constructions consist of the *Experiencer* in nominative case agreeing with the verb and the *Theme* in accusative.

(27) a. O Gianis   misi   to sholio.

The Gianis-M.SG.NOM hate-PRS.3SG.ACT the school-N.SG.ACC.

'John hates school.'

b. O Gianis   agapa   tin Maria.

The Gianis-M.SG.NOM love-PRS.3SG.ACT the Maria-F.SG.ACC.

'John loves Mary.'

c. O Gianis   latrevi   tin musiki.

The Gianis-M.SG.NOM adore-PRS.3SG.ACT the music F.SG.ACC.

'John adores music."

The Object-Experiencer psych verbs constructions, which include the *Experiencer* in accusative case and the *Theme* in nominative agreeing with the verb.

(28) I Maria   eksorgizi   ton Giani.

The Maria-F.SG.NOM. enrage-PRS.3SG.ACT the Giani- M.SG.ACC.

'Mary enrages John.'

(29) I kategides   to   fovisan

The thunderstorms-F.PL.NOM CL.NEUT.SG.ACC frighten-PST.3PL.ACT

to pedi.

the child-N.SG.ACC.

'The thunderstorm frightened the child."

The Object-Experiencer psych verbs constructions including verbs like 'aresi' (likes) and 'ftei' (bothers/matters). These constructions demonstrate the *Theme* in nominative case agreeing with the verb and the *Experiencer* either in morphological genitive or as the complement of the prepositional phrases. This category seems to be alike to the *piacere* verbs of Belletti and Rizzi (1988).

(30) To   sholio   aresi   ston   Giani.
      The school-N.SG.NOM like-PRS.3S.ACT to-the Giani-M.SG.ACC.
      'John likes school.'

(31) To   sholio   tu   aresi   tu
      The school-N.SG.NOM CL.M.SG.GEN like-PRS.3S.ACT the
      Giani.
      Giani-M.SG.GEN.
      'John likes school.'

Moreover, Kordoni (2001) investigates the semantic properties and the syntactic behavior of the Experiencer-Subject psych verbs including cases like the verb *fovame* (fear) which realizes the Object either in an accusative Theme or as a prepositional phrase without differing semantically:

(32) I Maria   fovate   tis kategides.
      The Maria-F.SG.NOM fear-PRS.3S.PASS the storms-F.PL.ACC.
      'Mary is afraid of the storms.'

(33) I   Maria   fovate   me   tis
      The Maria-F.SG.NOM fear-PRS.3S.PASS with the
      kategides.
      storms-F.PL.ACC.
      'Mary is afraid of the storms.'

In this study, Kordoni proposes a unified account for the Experiencer-Subject Psych Verbs Constructions based on the hypothesis that "the individual denoted by the *object* NP (or PP) of the Modern Greek Subject-*Experiencer* psych verbs constructions is

entailed to be semantically underspecified" (2001:199). In order to support her proposal she makes use of Wechsler's (1995) Notion Rule, Davis and Koening's (2000) linking theory and Markantonatou & Sadler's (1996) proposal for the linking of indirect arguments.

For Alexiadou & Iordâchioaia (2014) psych verbs do not belong to a specific category as far as their semantic and syntactic properties are concerned. What differentiates them is the fact that they can take part in the causative-anticausative alternation parallel to transitive verbs.

Taking into account the analyses presented and the data used in the papers examined in this section, it seems that in the majority of cases of Subject-*Experiencer* psych verbs constructions in Greek the Object is introduced to the sentence by the preposition *me* 'with' or *ja* "for", mostly when the sentence is in passive voice. The use of the preposition me 'with' is adopted for the creation of this study's stimuli.

As demonstrated in the present section and 3.4, there are both cases of atypical and non-canonical argument realization in psych verbs in Greek, meaning that in the *atypical* one the role of *Experiencer* is assigned to the first NP mapping onto the subject of the sentence (see example (h)), while in the *non-canonical* the *Theme* appears prior to the *Experiencer* in the surface level of the sentence, leading to incompatibility between the thematic hierarchy and the actual argument realization (see example (2d). Deviations of this kind have been examined in populations with different types of brain impairment, such as people with aphasia or agrammatism or types of dementia (Manouilidou et al., 2009; Thompson & Lee , 2009; among others), and showed that there are processing deficits in assigning the suitable θ-roles correctly both in sentences with psych verbs and passive voice (Terzi, 2015).

4
VERB PROCESSING IN DEMENTIA: COMPREHENSION AND PRODUCTION

4.1 Introduction

This chapter presents studies on the characteristics of verb comprehension and production regarding their argument structure in populations suffering from Mild Cognitive Impairment and Dementia, more specifically Alzheimer's disease. Verbs, as a word category, bear information in a sentence requiring the function of multiple mechanisms in the brain. The status of verb processing depends on the functions of the temporal lobe structures (Reilly et al., 2011) in order for someone to represent conceptual knowledge. According to many studies (e.g. Reilly et al., 2011; Patterson et al., 2007 ; Yi et al., 2007; Galton et al., 2001), cortical regions of the brain, responsible for language comprehension and production, are impaired in populations with Alzheimer's disease (henceforth AD). Pervasive evidence (Taler & Phillips, 2008; Albert et al., 2011; Sperling et al., 2011; Mueller et al., 2018) lead to indications revealing an upcoming AD years before clinical symptoms can be detected leading to a diagnosis. Language impairment is one of the symptoms that arise before the onset of the clinical symptoms, according to Taler & Phillips (2008).

According to previous studies (e.g. Bayles, 1982; Chapman & Ulatowska, 1994; Caramelli et al. 1998), people with AD go through stages of impairment regarding language and communication abilities. Early on, they show anomia symptoms (Rochon et al., 2018) and impairment in verbal fluency, meaning that the temporal lobes are affected. Later on, we observe deficits at a semantic - pragmatic level, which affect discourse. In this stage, they present difficulties in the comprehension of complex syntactic and semantic structures. At the same time, informational content deficits and referential errors are detectable as well, which in terms of brain structure means that the temporal, parietal and occipital lobes are affected. At late stages, language as a mechanism/function is affected completely, because neurons stop functioning and connections between neurons are lost leading to impairment of the frontal lobes. With the early onset of AD we can observe gradual shrinkage of the cortex and especially the hippocampus as well as enlargement of the verticals.

Most of the studies regarding language deficits in populations with AD focus on the comprehension of sentences with a particular interest in the processing of nouns and verbs. Verb production and comprehension has received less attention than nouns across the studies conducted into language impairment in dementia. However, considerable research has investigated verb deficits with a narrow scope focusing on morphosyntactic features, such as Tense (e.g. Ullman et al., 1997) or Aspect (e.g. Fyndanis et al., 2013; Fyndanis et al., 2018).

As the language deficit in AD is very much semantically based (Kim & Thompson, 2004; Aronoff et al., 2006; Almor et al., 2009), in this review chapter I set out to examine the performance of populations with MCI and AD, regarding the interface between semantics and syntax, specifically whether there is a semantic deficit in terms of comprehension and production in verb argument structure with a particular interest in thematic roles.

4.2 Verb argument structure in Mild Cognitive Impairment

Previous work examining linguistic deficit in people with Mild Cognitive Impairment (MCI) (Griffith et al. 2006; Riberio et al., 2006) demonstrated that language impairment begins before entering dementia. However, little research has been done in order to define more precisely the linguistic deficit in the precursor of dementia, MCI. Regarding verb argument structure even less research has been conducted, therefore the following studies in review show the deficit in the interface of syntactic-semantic relations and the influence that the function of Working Memory has even at this prior stage of dementia.

Sung et al. (2013) conducted a study aiming to assess comprehension of passive sentences in Korean-speaking population with MCI in relation to their Working Memory Capacity. 18 people with MCI and 17 normal elderly individuals were tested through a comprehension task and a set of tests for the Working Memory assessment. The comprehension task consisted of 3 kinds of sentences: 1) active sentences with intransitive verbs, 2) active sentences with transitive verbs and 3) passive sentences. Sung et al. aimed to examine, on the one hand, if individuals with MCI demonstrate a deficit in the comprehension of passive structures compared to active ones, and on the other hand, whether their Working Memory performance can be a prognosis-marker for

their linguistic performance regarding passive sentences. Results of this study showed that individuals with MCI faced significant difficulty comprehending passive structures compared to the healthy group. What is remarkable in this study's results, is the fact that the performance of both groups in the set of Working Memory assessment predicted their performance in the comprehension task. What is more, the researchers reported that persons with MCI were able to use morphological cues of case in passive structures in order to interpret them. This finding led them to propose the necessity of cross-linguistic investigation of linguistic abilities in population with MCI.

Sherman et al. (2013) investigated whether there is a syntactic-semantic deficit in populations with MCI by examining the performance of 13 people with MCI, 14 healthy aging adults and 10 young adults in two tasks of elicited imitation. The first task consisted of 12 coordinate sentences and the second task included 24 relative sentences, both of different levels of semantic plausibility, e.g. "The student opened the backpack and the student erased the blackboard." and "The attorney presented the evidence which freed the defendant." respectively. Results showed that healthy aging individuals faced difficulties regarding semantic plausibility, but not regarding syntactic complexity. Participants with MCI demonstrated increasing deficit in both semantic plausibility and syntactic complexity as the difficulty of the task raised, meaning that the interface of syntax and semantics is impaired. Sherman and his colleagues concluded that language features at sentence level in both healthy aging and MCI are compromised, especially regarding the interface of semantic and syntactic levels.

Furlan (1994) conducted a study that examined repetition of non-canonical linguistic constructions in people with MCI. 9 Italian-speaking individuals, 10 healthy aging ones and 10 young adults participated in the study. Furlan used two repetition tasks, one examining immediate recall of sentences and the other examining delayed recall involving a distractor, using non-canonical word order, Object-Subject-Verb instead of the canonical Subject-Verb-Object. The difficulty of the tasks was detected firstly on the complexity of the sentences and secondly on the necessity of Working Memory's maintenance, as repetition requires procedures of both comprehension and production while holding Working Memory active. Results of this study demonstrated overall deficit regarding non-canonical syntactic structures, which was explained as a consequence of attentional and syntactic impairment in processing procedures.

To sum up, previous research suggests that both processing of verb related information and Working Memory Capacity is compromised in MCI. Therefore, at this level there is significant need to further investigate the domains of deficit that may be detectable in pre-dementia.

4.3 Verb argument structure in Alzheimer's disease

4.3.1 Comprehension of verb argument structure in Alzheimer's disease

Most of the studies into verb deficit in Alzheimer's disease focus on both semantic and syntactic processing of the information that verbs bear in a sentence. In order to explain how individuals with AD process verb related information in terms of semantics, some studies examined in this review chapter employ the use of thematic roles with regard to the notion of canonicity in verb-argument relations (e.g. Small et al., 2000; Manouilidou et al., 2009; Manouilidou & de Almeida, 2009). In order to verify individuals with AD's reliance on the canonicity of theta-role assignment, authors take into consideration either passive structures or verbs characterized by cases of non-canonical argument realization.

Bickel et al. (2000), Waters et al. (1998), and Kemper et al. (1998) tested patients' mastery of passive structures through sentence-to-picture matching tasks (hereafter SPMTs), and obtained rather sound results. Bickel et al. (2000) did not find any significant difference between active and passive sentences. However, within the latter condition, they noticed that reversible passives challenge people with AD more than non-reversible passives do. That means that people's with AD processing of passive structures benefits from the presence of an inanimate referent included in the passive sentence, which is less probable to be assigned the *Agent* θ-role.

Waters et al. (1998) gathered similar results with a SPMT and a video judgment task. In the latter, participants were asked to judge whether the stimulus sentence they heard is in accordance to the video content. In both tasks, people with AD performed equally well to the comprehension of both active and passive sentences.

Moreover, Grossman and White-Devine (1998) examined the sentence comprehension deficit in Alzheimer's disease with regard to grammatical and semantic aspects of the verbs. The use of θ-roles was employed in order to examine the processing of 22 individuals with AD regarding verb argument structure. The material

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they chose to present in the target sentences was of two types of verbs, simple transitives and lexical causatives in active and passive voice. Their prediction was that people with AD would face more difficulties with lexical causatives than simple verbs, because the first type of verbs is associated with an "atypical syntactic-theta mapping", as Grossman and White-Devine mentioned. This kind of mapping is signaled implicitly at a surface level due to lack of morphological cues and therefore, more cognitive resources were needed in order for the patient to achieve an accurate process of verb comprehension (Geyer and Grossman, 1994). In particular, Grossman & White-Devine (1998) analyzed the case of causative verbs:

(34) John drowns the swimmer

In (34), the actual agent of the drowning action is the swimmer, as made explicit by the use of the verb in its intransitive form:

(35) The swimmer drowns

The same meaning as in (34) can further be conveyed by a periphrastic causative structure:

(36) John made the swimmer drown

Grossman & White-Devine (1998) sampled participants' comprehension of active sentences with transitive verbs, with causative verbs (34) and with periphrastic causative structures (36), while they manipulated the set of sentences by using divergent sentence frames: active (34), passive (35) and periphrastic (36). Participants listened to the sentences and then answered Yes/No questions (e.g. 'Did the swimmer drown?' or 'Did John drown?'). Their results showed that voice did not affect the comprehension of thematic roles, but there was observed significant deficit in comprehending the periphrastic sentences due to their complexity. They claimed that the deficit in comprehending the type of semantic-syntactic mapping characterized by atypicality is due to the need of a combination of cognitive processes and more importantly, this

deficit was correlated with the semantic memory impairment of people with AD. They employed the results of two studies to give further support to their finding. Rochon et al. (1994) and Waters et al. (1995) reported that sentences containing a larger number of propositions are more difficult for AD individuals to comprehend, a finding towards the same directions as the result of Grossman & White-Devine's study.

Furthermore, Price and Grossman (2005) conducted a study in order to examine verb transitivity and θ-role assignment in people with AD and frontotemporal dementia (FTD). 15 individuals with AD were able to choose correctly in terms of grammatical structure, but showed difficulty with θ-role agreements. 14 individuals with FTD were insensitive to both factors, transitivity and thematic agreements. The procedure used was an on-line word detection paradigm based on Marslen-Wilson & Tyler's (1980) and Tyler's (1985) method. In order to examine whether there is decreasing performance with thematic agreement violation, they used sentences with clear and evident subject-verb relationship (e.g. "The cat scratches …") and sentences with violation of thematic relations (e.g. "The air scratches…"). The results showed that individuals with AD had a selective thematic role deficit, but not for transitive sentences, meaning that they performed quite well as regards thematic agreement violations as they did in the case of transitive sentences. An analysis of individual participant performance profiles showed that five of the six people with SD of the FTD group had a greater discrepancy in their latency to respond to a target word immediately following a thematic agreement. This is not a significant finding, but Price and Grossman claimed that this is an indication of association between thematic role knowledge in verbs and in lexical semantic knowledge, which is reported as impaired in SD. The data from this investigation are consistent with previous work suggesting that verbs play multiple roles in sentence processing, and observations regarding the performance of people with AD suggest that some of these roles are dissociable. In contrast, they have difficulty processing a verb's thematic roles. There is much speculation about the precise basis for this impairment, but additional work is needed to determine whether this is related to degradation of verb thematic role knowledge or a deficit in processing this component of a verb. The pattern of performance in FTD differs from that seen in AD. Unlike in AD, they did not observe sensitivity either to the processing of thematic roles or to comprehension of transitive sentences in FTD. This was despite the relatively automatic nature of the on-line task. To sum up focusing

on AD, Price and Grossman supported that verb agreement processing is compromised in people with AD. Comprehension of thematic roles, but not transitivity, is impaired in AD. They supported that this may be associated with a broad-based degradation in verb knowledge, or difficulty with structure building that is also associated with comprehension of thematic roles in a sentence.

Taking into consideration the studies previously mentioned, Manouilidou et al. (2009) developed their approach for theta-roles in people with AD in terms of hierarchy violations in psychological predicates. In order to examine how people with AD perform with θ-role assignment they chose two types of sentences in terms of canonical hierarchy, one that corresponds to the canonical thematic hierarchy, where *Agent* and *Theme* are the basic roles in a sentence (e.g. "The teacher accompanied the students"), and non-canonical thematic hierarchy with psych verbs (e.g. fear, frighten). In other words, they used Subject-*Experiencer,* Object-*Experiencer* and agentive verb types in both active and passive voice in order to ensure that θ- roles would be examined in terms of syntactic frame as well. The results of this study showed that there are several factors at play concerning thematic role assignment. Individuals with AD performed worse in sentences with psych verbs and even worse with sentences violating the canonical thematic hierarchy, as they are additionally difficult. Voice, just like in the study of Grossman and White-Devine (1998), did not play a role in the performance of AD individuals. The most important finding was the recognition of the [+agentive] feature as of great significance in thematic role assignment in AD populations.

Later on, Manouilidou and de Almeida (2009) examined the results of Manouilidou's et al. (2009) study taking into account not only thematic hierarchy, but also animacy hierarchy and proto-roles. As Manouilidou & de Almeida note, animacy hierarchy has been discussed by various authors (e.g. Silverstein, 1976; Morolong and Hyman, 1997) and from various theoretical standpoints. For instance, there is the notion of person hierarchy. Person hierarchy in the frame of a sentence means that, when three people are mentioned, then the first and second person dominate the third. Other types of animacy hierarchy are the NP-type hierarchy (i.e Pronouns> common nouns) and Animacy hierarchy proper proposed by Croft (2003:130). Manouilidou & de Almeida (2009) adopted the last type of animacy hierarchy by Croft (2003), which follows a hierarchy of humans> nonhumans animates> inanimates, claiming that "animacy constraints on verbs' arguments are computed online and can affect verb processing"

(p. 127). Similar enough is the approach of Dowty (1991), who proposes two prototypical role types, Proto-Agent and Proto-Patient, which they employ as well in order to examine more accurately the impairment of θ-roles assignment in people with AD. Employing the theoretical approaches mentioned previously they observe that the role of the Agent plays the leading role in comprehension. In case there is no Agent, thematic hierarchy is employed for comprehending sentences by people with AD.

Furthermore, Grossman et al. (1996) focused on verb comprehension deficits among people with AD with regard to verb-argument structure in sentences. They used three different types of perceptual and non-perceptual verbs: 3 motion verbs, 3 cognition verbs and 4 perception verbs, but only 5 of these had complex argument structure involving a prepositional phrase (PP) in sentences with motion and motion-like verbs, and 5 others containing a sentential complement in sentences with cognition and cognition-like verbs. Their aim was to explore if people with AD would be able to process semantic relations that were not detectable in terms of grammatical differences. Using a semantic meaning task and a sentence coherence task, they observed that individuals with AD could not coherently perceive the semantic relations between the verbs and that, furthermore, there is strong correlation between the deficits demonstrated by individuals with AD in both tasks. This finding led Grossman et al. to observe that there might be "a common source of compromised semantic and structural appreciation of verbs in pAD" (p.384). That finding is explained by Grossman et al. by claiming that people with AD show impairment at both a semantic and syntactic level due to a common function that is possibly responsible for the comprehension of all semantic and syntactic properties of verbs.

In the study of Grossman et al. (1997) 16 individuals with AD were tested for their assessment of learning new words. They focused on the comprehension of the verb "wamble" as a self-motion type of verb with the meaning of "the act of returning to one's home", as they mentioned (p. 447), in terms of both syntactic and semantic processing level. "Wamble" was a new word, to which people with AD were exposed. Among other tasks, the researchers used a thematic role judgment task in order to test whether the participants with AD judged the sentences as coherent or incoherent. The task consisted of 30 sentences with the main thematic roles of the *Agent, Direction* and *Goal*, which were manipulated in order to test violations of selection restrictions with regard to choosing the expression occupying a certain position, for example the

complement of the verb. As Grossman et al. explained the *Agent* could be (a) an animate object that can bear movement, (b) an animate object that cannot bear movement and (c) an inanimate object. The *Direction* θ-role indicated (a) a path towards a target by using a preposition, (b) a path beyond a target, and (c) a non-spatial preposition. The *Goal* corresponded to (a) a home that was suitable for the agent, (b) a target that was associated with the *Agent* but not homelike (inanimate), and (c) a location that was not likely to be associated with the agent. This study showed that AD individuals, compared to healthy controls that were age- and education-matched, had no difficulty in recognizing when a verb should be put in a verb slot, but performed worse in demonstrating the correct theta-roles when the novel verb "wamble" was examined, meaning that individuals with AD were detected with a deficit in the acquisition of new verb-related argument structure, but not at the grammatical level (form of the word).

A semantic anomaly judgment task was conducted on 14 individuals with AD by Kim and Thompson (2003) aiming to detect whether there is a deficit in the knowledge and acquisition of θ-role assignment regarding the complements of the verbs. The experimental task consisted of 44 sentences, 22 plausible and 22 anomalous. For the anomalous sentences 11 verbs were used: (a) one 1-place verb, (b) three 2-place verbs, and (c) seven 3-place verbs. The majority of the sentences contained a Theme violation, three an *Agent*- and one a *Goal*-violation. Kim and Thompson (2003) reported no significant impairment in the performance of AD individuals with regard to linguistic complexity in the morphosyntax of the verb domain.

Kim and Thompson (2004) investigated verb deficits of AD individuals in comparison with agrammatic patients and healthy controls by examining parameters affecting verb retrieval and the use of verb knowledge in sentence processing. They investigated the processing of verb-argument structure through two tasks, (a) a naming and comprehension task and (b) a grammaticality judgment, in terms of comprehension. In the first task they used verbs with different argument structure depending on the number of arguments corresponding to the verb, i.e., they used twelve 1-place, twelve 2-place and twelve 3-place verbs. In the second task they tested the abilities of the participants regarding the detection of grammatical violations in verb argument structure. They used canonical sentences, half grammatical and the other half ungrammatical, with a different number of obligatory arguments. Kim and Thompson (2004) reported that the subjects with AD faced difficulties in processing verb-related

information, but did not show a serious impairment. They provided an explanation for this kind of deficit co-examining the results of this study and the study mentioned previously (Kim and Thompson, 2003). They found that the deficit is observed in the processing of both the level of semantics and the level of syntactic structure, when it comes to the assignment of θ-roles.

Markova et al. (2017) conducted a study into the comprehension abilities of Slovak-speaking persons with AD at the sentence level. They aimed to examine whether there is significant difference in sentence comprehension between people with mild and moderate AD and cognitively intact elderly people. They also investigated possible effects of other factors, such as order of thematic roles, length of the sentence examined on sentence comprehension of both groups of people. As regards the order of thematic roles, they used sentences with canonical and non-canonical order. In the sentences with canonical order of thematic roles they employed center-embedded relative clauses, with the subject of the matrix clause having the *Agent* role. The non-canonical order of the thematic roles was represented at the sentence level by assigning the *Patient* role to the first noun in sentences with Object-Verb-Subject order, a center-embedded relative clause or a right branching relative clause upon which the subject of the main clause. The results of this study showed that the AD group performed worse than the elderly controls overall. More specifically, people with moderate AD demonstrated deficits in the comprehension of both canonical and non-canonical sentences regardless from the form and the constituent of the sentence. Individuals with mild AD faced difficulties in comparison with the elderly controls in comprehending Object–Verb–Subject word order sentences with agentive verbs and more complex syntactic structures. Participants with mild AD showed decreasing performance especially with the sentences consisting of the matrix clause and a center-embedded relative clause. Markova et al. supported that this performance of people with AD constitutes evidence for linguistic impairment, confirming previous studies (Bickel et al., 2000; Kempler et al., 1998; Lukatela et al., 1998; among others), which gets worse as deficient cognitive resources in language processing decrease due to brain regions' shrinkage.

Taken together, findings from the studies reviewed in this section illustrate that participants with AD do not face difficulties with thematic roles, when these are not deviating from the canonical hierarchy. Passive structures with a *Theme/Agent* reversed

order are not problematic. As Grossman and White-Devine (1998), Manouilidou et al. (2009), Manouilidou and de Almeida (2009) highlighted, voice did not play a significant role for the assignment of thematic roles, meaning that syntactic structure does not affect the perception of conceptual knowledge that verbs bear and assign to the NPs of the sentence as θ-roles. This is because in deep structure the two roles are canonically assigned: *Agent* constitutes external argument and *Theme* the internal one. Although the order is reversed at the surface level, people with AD are able to process the sentences. Furthermore, a significant parameter, as Manouilidou et al. (2009, p. 171) mentioned, which some studies did not take into account (Price and Grossman, 2005) is the pragmatic plausibility discussed by Saffran et al. (1998) for aphasics. Pragmatic plausibility affects the assignment of thematic roles and should not be ignored regarding the thematic roles' comprehension and production in AD populations. Furthermore, different parameters must be taken into account concerning the extent of impairment of semantic memory, working memory and other cognitive resources. Moreover, the feature of [+animacy] seems to play a role in verb argument structure, as most of the studies including this parameter (Manouilidou et al., 2009; Manouilidou and de Almeida, 2009; Grossman et al., 1997; Price and Grossman, 2005) showed that there is a slight influence of this feature on the assignment of thematic roles.

4.3.2 Production of verb argument structure in Alzheimer's disease

A considerable number of studies have been conducted aiming to investigate the production of language in populations with Alzheimer's disease in terms of morphosyntax and lexical aspects of speech (e.g. Fyndanis et al., 2013; Fyndanis et al., 2018). Fewer studies have examined verb-argument structures in speech production.

More specifically, Small et al. (2000) focused on sentence production in populations suffering from AD using different types of sentences in a sentence repetition task. One of the parameters examined in this study was the canonicity in verb-argument structure based on how people with AD assign the non-canonical theta-roles. The material they used as non-canonical sentences was only in the passive voice, in contrast with other studies (e.g. Grossman and White-Devine, 1998; Manouilidou et al., 2009). They observed that syntactic movement played a significant role in the AD patients' ability to repeat complex sentences. The most important observation was made by examining the results taking into consideration the processing resource capacity and

correlating them with their working memory performance. In contrast with studies regarding comprehension of verb argument structure, the number of propositions included in a sentence did not play such a significant role in the repetition task. Finally, sentence-repetition performance gives further support about the fundamental role that cognitive resources, such as Working Memory, play in the processes of the language mechanisms.

Another study by Altman et al. (2001) focused on the speech errors that individuals with AD make in terms of morphosyntax using production tasks. Examining 10 individuals with AD and 15 controls healthy age- and education-matched English speakers they observed that morphosyntax is intact. However, participants with AD made errors more easily than controls. Although this study did not examine verb-argument structure in speech production, it includes a task, the constrained production task, which requires from the participant to produce a grammatical sentence consisting of a verb and two noun phrases, evoking the assignment of theta-roles. More specifically, they used simple sentences with (a) main theta-roles the *Agent* and the *Theme* (e.g. Tommy kicked the ball), (b) main theta-roles *Experiencer* and *Theme* and (c) the same semantic-structural association with (a) but differing morphologically. Both (a) and (c) had transitive verbs, but in category (c) verbs were irregular in the form of past participle. In the (a) and (c) cases, *Agent* responded as a subject and *Theme* as an object in terms of grammatical structure, while in the (c) case the *Theme* corresponded to the subject and the *Experiencer* to the object. An important detail is that the sentences with active verbs had the form "inanimate noun-verb-animate noun", as Altman et al. mentioned, and the type of the form, regular or irregular, did not affect the assignment of the θ-roles. Among other impairments in the AD individuals' performance, Altman et al. observed difficulty in the production of sentences with canonical argument structure. They employed different theories in order to explain the deficits in speech production, such as modular models proposed by Garrett (1980, 1984), which they rejected. They adopted the theory by Levelt (1989), according to which the syntactic-semantic level cannot be examined separately and therefore theories explaining a deficit without taking into account both levels are not acceptable by Altman et al. They suggested that the linguistic deficit resulting from their experiment might have a gradation due to impairments of multiple functions of the language production (e.g. lexical, grammatical, semantic and/or syntactic).

Kim and Thompson (2004), as previously presented, also used production tasks testing verb argument structure. The participants were asked to produce narratives about the story of Cinderella after being exposed to a picture book depicting the Cinderella story. The results showed that generally participants with AD achieved a high accuracy score (90%) in the production of correct arguments, but faced difficulties with regard to the production of 1-place and 3-place type of verbs. It is pointed out that verb production (and processing) impairment in AD individuals may be based in a "'bottom-up breakdown of verb lexicon' hypothesis" as Kim & Thompson mention (p.13), and they made an attempt to associate verb deficits with noun deficits, which they also encountered in their study, proposing that the same mechanisms of processing might be used for both nouns and verbs.

To sum up, there is a research gap in examining the production of verb argument structure, especially regarding the assignment of thematic roles in psychological verbs. What is more, assignment of thematic roles hasn't been thoroughly investigated and in a variety of languages. When examining linguistic abilities, it is essential to consider parameters that strongly influence language use, such as the frequency of occurrence of words, constructions and syntactic structures. The factors taken into account in order to explain the declined performance of populations with MCI and AD are mostly the cognitive abilities; in particular the function of the Memory (Working & Semantic). There are contradictory evidence regarding the influence of the Working Memory in the assignment of θ-roles. Consequently, these issues are still open for investigation.

5
METHOD OF THE PRESENT STUDY

5.1 Goal and Research Questions

As mentioned in the Introduction Chapter, the goal of this study is to further investigate linguistic deficit regarding θ-role assignment in psych verbs in both production and comprehension. Furthermore, in order to understand better the deficit in verb argument structure, I address the following questions:

1. Is there a deficit in the mapping between syntactic and semantic representations in psych verbs in populations with MCI and AD?

2. Does the performance of people with MCI and AD get worse as the disease progresses?

3. Does the frequency of the verb's appearance in everyday life play a role in the performance of people with MCI and AD?

4. Are the linguistic difficulties of the population with MCI and AD related to Working Memory Capacity?

The first question is going to be answered through the use of two sentence-picture matching tasks (SPMTs), a production and a comprehension SPMT, which require from the participants to proceed in assigning θ-roles not only to psych verbs (*Experiencer*-verbs), but also to *Agent*-verbs, so that discrimination between the severity of deficit regarding psych verbs can be assessed. Based on previous research, as presented in the previous chapter, the expectation is that there will be deficit in the assignment or θ-roles in psych verbs (*atypical* and *non-canonical* hierarchy), so much to the MCI group as to the AD groups, but not for *Agent* active and passive verbs. Based on previous work (Manouilidou et al., 2009), it is also expected that voice will not play a significant role in the performance of population with MCI and AD.

The second question will be answered by comparing the performance in both SPMTs between the three groups of people with MCI and AD and it is expected that as the disease progresses, so will the deficit increase, just like cognitive abilities demonstrate decrease.

Frequency influences the levels of accuracy (Estes & Maddox, 2002), when people are assigning θ-roles. More specifically, when a concept defined by the verb (predicate) is widely known, then the assignment of θ-roles gets easier and more accurate. This parameter is taken into account in order to shed light to factors that may influence language abilities in population with (pre-) dementia. This question is answered by the discrimination of stimuli in frequent and rare ones in both SPMTs, not only in the cases of psych verbs but also in the cases of *Agent*-verbs. Therefore, frequency is expected to influence the mapping of thematic relations onto syntactic structures that underlie psych verbs.

The fourth question investigates whether and how Working Memory Capacity influences language abilities and more specifically, the assignment of θ-roles. It was observed in previous work that the Working Memory is strongly involved in the use of language as it is used for temporary storage of sentences as they are processed by language mechanisms. Working Memory tests, presented in the following sections, will be used in order to answer this question. Based on previous research, it is expected that Working Memory will play significant role in the production and comprehension of θ-roles.

5.2 Participants

5.2.1 Individuals with MCI

Twenty monolingual, Greek-speaking individuals with MCI (15 females and 5 males; mean age 74.7 years) participated in the study. The participants were visitors of the Day care Centers "Agia Eleni" and "Agios Ioannis" of the Greek Association of Alzheimer's Disease and Related Disorders (Alzheimer Hellas) in Thessaloniki. None of the individuals had hearing problems and most of them had no visual problems. Those who had visual problems (presbyopia/long-sightedness) used their glasses to participate adequately in the study. The participants had awareness of their memory deficiencies. All the individuals had been educated with an average of education years 11.3. None of the individuals had a history of prior neurological disease, drug or alcohol abuse, developmental speech/language disorders, learning disabilities, or psychiatric disorders, except for anxiety disorder, for which they did not take medication. The diagnosis of MCI was in accordance to the criteria established by Petersen et al. (2001). Results of the Greek versions of the Mini-Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975; Fountoulakis et al., 2000), the Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005; Kounti et al., 2007), Functional-Cognitive Assessment Scale (FUCAS; Kounti, Tsolaki & Kiosseoglou, 2006) and the Clinical Dementia Rating (CDR; Morris, 1993, 1997; Morris et al., 1997; Kantoglou E., 2010) demonstrated that all participants showed Mild Cognitive Impairment (see Table 1). These results were verified clinically by medical work up. After being thoroughly informed about the study, its goals, the benefits of the results, and confidentiality of

personal data, all subjects participated voluntarily, and signed the declaration of consent.

Table 1

MCI group means for Age, Education, MMSE, CDR, FUCAS and MoCA variables

	N	Mean
Age	20	74.70
Education	20	11.30
MMSE	20	27.55
CDR	20	1.175
FUCAS	20	43.40
MoCA	20	23.70

5.2.2 Individuals with Alzheimer's Disease

Twenty seven individuals with AD participated in the study. One was excluded because his native language was not Greek and he was a multilingual. The twenty six individuals were monolingual and had Greek as their native language. Sixteen of them were diagnosed with mild AD (10 females and 6 males; mean age 75 years) and the other ten were with moderate AD (5 females and 5 males; mean age 78.55 years). The participants were visitors of the Day care Centers "Agia Eleni" and "Agios Ioannis" of the Greek Association of Alzheimer's Disease and Related Disorders (Alzheimer Hellas) in Thessaloniki. None of the individuals had hearing problems, but some of them had visual impairments. Those who had visual problems (presbyopia/long-sightedness) used their glasses to participate adequately in the study. All individuals had been educated for at least 6 years (mean education years for AD mild: 9.6; mean education years for AD moderate: 8.1). None of the individuals had a history of prior neurological disease, drug or alcohol abuse, developmental speech/language disorders, learning disabilities, or psychiatric disorders, except for anxiety disorder, for which they did not take medication. The diagnosis of AD was in accordance to the criteria established by the National Institute of Neurological and Communicative Disorders and Stroke-Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA; McKhann et al., 1984). Results of the Greek versions of the Mini-Mental State Exam

(MMSE; Folstein, Folstein, & McHugh, 1975; Fountoulakis et al., 2000), Functional-Cognitive Assessment Scale (only for mild AD) (FUCAS; Kounti, Tsolaki & Kiosseoglou, 2006), the Global Deterioration Scale (GDS) (Reisberg, 2007; Pornari Ch., 2010) and the Clinical Dementia Rating (CDR; Morris, 1993, 1997; Morris et al., 1997; Kantoglou E., 2010) demonstrated that all participants showed mild to moderate Alzheimer's Disease (see Table 2 & 3). These results were verified clinically by medical work up. After being thoroughly informed for the study, its goals, the benefits of the results, and confidentiality of personal data, all subjects participated voluntarily, and all subjects' caregivers signed the declaration of consent.

Table 2

AD mild group means for Age, Education, MMSE, CDR, FUCAS and MoCA variables

	N	Mean
Age	16	75.00
Education	16	9.69
MMSE	16	20.38
CDR	16	4.850
FUCAS	16	50.73
MoCA	16	22.14

Table 3

AD moderate group means for Age, Education, MMSE, CDR, FUCAS and MoCA variables

	N	Mean
Age	11	78.55
Education	11	8.18
MMSE	11	14.09
CDR	11	10.591
FUCAS	0	
MoCA	11	73.36

5.2.3 Elderly Controls

Three groups of healthy elderly population participated in the study as control groups. Forty seven healthy participants were matched for age and education with the participants with MCI, AD mild and AD moderate accordingly. Healthy individuals constituting the control groups had to perform at ceiling on the MMSE test, meaning that their test scores were strictly equal to 29 or 30 out of 30. Likewise, they had to perform at ceiling to the FUCAS test, which is in agreement to test scores of 42 and not higher, and to the MoCA test, meaning that scores should be above 24 when education years are from 0 to 12 and above 26.91 when education years are above 12. Finally, they had to perform lower than 5 out of 15 to the GDS test[2].

After being thoroughly informed about the study, its goals, the benefits of the results, and confidentiality of personal data, all subjects participated voluntarily and signed the declaration of consent.

5.3 Material

5.3.1 Neuropsychological evaluation

The tests, which were administered for the neuropsychological evaluation by the scientific personnel of the Greek Association of Alzheimer's disease and Related Disorders (Alzheimer Hellas), aimed to assess:

5.3.1.1 The executive cognitive function in daily life activities

Functional Cognitive Assessment Scale (FUCAS) (Kounti et al., 2006), for the immediate assessment of executive function in daily activities and

Functional Rating Scale of Symptoms of Dementia (FRSSD) (Dejong et al., 1989) for the indirect examination of daily functioning.

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[2] Based on a medically reviewed article by Heerema, E.(2020, Jan 28). *Overview of the Geriatric Depression Scale (GDS).* Verywellmind. https://www.verywellmind.com/geriatric-depression-scale-98621

5.3.1.2 The cognitive abilities

Mini Mental State Examination (MMSE) (Fountoulakis et al., 2000) for the assessment of the general cognitive performance,

Montreal Cognitive Assessment (MoCA) (Kounti et al., 2007) for the overall evaluation of cognitive abilities, only for individuals with MCI.

CAMCOG test (Tsolaki et al., 2000) to measure the degree of dementia and to assess the extent of cognitive impairment.

Trail-making Test (part A, part B) (Poptsi et al., 2007), for the evaluation of the ability to concentrate, process information, attention and abstract thinking.

Rey Auditory-Verbal Learning Test (RAVLT) (Kounti et al., 2004), for measuring the short-term auditory-verbal memory, rate of learning, learning strategies, retroactive, and proactive interference, short-term and long-term retention of information.

Rivermead Behavioural Memory Test (RBMT) (Efklides et al., 2002), only the short-term and long term recall

Test of Every Day Attention (TEA) (Robertson, 1994; Messinis et al., 2011), for evaluation of different facets of attention.

Rey Ostereith Complex Figure Test (ROCFT) (Kounti et al., 2004), a complex figure aiming to measure visuospatial abilities, working memory, planning, attention.

5.3.1.3 The emotional status

Beck Depression Inventory (BDI) (Beck et al., 1961), for the evaluation of symptoms and behavior towards depression.

Beck Anxiety Inventory (BAI) (Beck & Steer, 1990), for measuring frequency and significance of common physical symptoms of anxiety.

Geriatric Depression Scale (GDS) (Fountoulakis et al., 1999), for detection of depression levels in geriatric population.

5.3.1.4 Working Memory Tests

For assessment of working memory of all participants, with MCI or dementia and healthy controls, the Digit Span test was used. The Digit Span is a subtest of both the Wechsler Adult Intelligence Scale (WAIS) (Wechsler D., 1955, 1981) and the Wechsler Memory Scales (WMS) (Wechsler D., 1981). Wechsler's Digit Span Task comprised

of two parts – digits forward, where the subjects are asked to repeat increasing sequences of digits in the order they were presented by the examiner; and digits backwards, where the subjects are asked to repeat increasing sequences of digits in reverse order. In both parts, three trials preceded the tested materials to ensure that the participant understood the task. Forward span examines attention mostly, while backward span as an executive task assesses working memory.

5.3.2 SPMT for Production

The present study adopted parts of the experimental design of the study realized by Thompson et al. (2009) on agrammatic aphasic speakers and the overall idea of examined material from the study of Manoulidou et al. (2009) on individuals with AD.

In order to establish the tests for production and comprehension, six Subject-*Experiencer* psych verbs and six Subject-*Agent* non-psych verbs (or *Agent*-verbs) were selected based on their written frequency of occurrence from the Hellenic National Corpus (HNC) database (see Table (14) in Appendix B). These verbs then were placed in semantically reversible sentence frames (Thompson & Lee, 2009) by employing the passive voice, in which they were assigned the role of Object-Experiencer, resulting in 24 stimulus sentences (see examples (37), (38), (39), (40); see Appendix A for all stimuli). Then black and white pictures were prepared corresponding to the 24 stimulus sentences (see Appendix A).

(37) Object-*Experiencer* frequent psych verb:

Ο σκύλος φοβίζει τη γάτα.

The dog-M.SG.NOM. frighten- PRS.3SG.ACT. the cat-F.SG.ACC.
'The dog frightens the cat.

Subject-*Experiencer* frequent psych verb:
Η γάτα φοβάται με το σκύλο.
The cat-F.SG.NOM. frighten-PRS.3SG.PASS. with the dog-M.SG.ACC.
'The cat is frightened by the dog.

(38) Object-*Experiencer* rare non-psych verb:
Η νοσοκόμα ξαφνιάζει την ασθενή.
The nurse-F.SG.NOM surprise- PRS.3SG.ACT. the patient-F.SG.ACC.
'The nurse surprises the patient.'

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Subject-*Experiencer* rare non-psych verb:

Η   ασθενής   ξαφνιάζεται   με   τη νοσοκόμα.
The patient-F.SG.NOM surprise- PRS.3SG.PASS. with the nurse-F.SG.ACC.
'The patient is surprised by the nurse.'

(39) Subject-*Agent* frequent non-psych verb:

Ο   ελέφαντας   πατάει   τον άνθρωπο.
The elephant-M.SG.NOM step.on- PRS.3SG.ACT. the human-M.SG.ACC.
'The elephant steps on the human.'

Object-*Agent* (by phrase) frequent non-psych verb:

Ο άνθρωπος   πατιέται   από τον ελέφαντα.
The human-M.SG.NOM. step- PRS.3SG.PASS. from the elephant-M.SG.ACC.
'The human was stepped by the elephant.'

(40) Subject-*Agent* rare non-psych verb:

Ο   νεαρός   βρέχει   την κοπέλα.
The youngster-M.SG.NOM wet- PRS.3SG.ACT the girl-F.SG.ACC.
'The youngster makes wet the girl.'

Object-*Agent* (by phrase) rare non-psych verb:

Η κοπέλα   βρέχεται   από   το νεαρό.
The girl-F.SG.NOM. wet- PRS.3SG.PASS. from the youngster-M.SG.ACC.
'The girl gets wet by the youngster.'

The picture-stimuli correspondence was pre-tested with 45 unimpaired participants, both males and females, all native speakers of Greek aged from 25 to 30 years old. Only pictures that did not evoke any difficulty from all unimpaired subjects were used in the experiment.

Although the same stimuli were used for both the comprehension and production tasks, for the production task target verbs were placed right below each picture, so that every participant would use them to describe the picture displayed in front of them.

5.3.3 SPMT for Comprehension

For the comprehension task, the same 24 stimuli were used. The difference is that in this task two pictures corresponded to one sentence. One picture showed the situation described by the sentence pronounced by the researcher, the correct picture, and the other one was a misleading image working as a distractor with the reverse assignment of roles (see Appendix A).

5.4 Procedures

Neuropsychological Evaluation was assessed before the Working Memory Tests and the SPMT of Production and Comprehension with less than a month intervening and was conducted in two sessions with duration of one and a half hour each. Working Memory Tests, SPMT of Production and of Comprehension were administered in on session with approximately 25 minutes duration. Most participants had 2-3 minutes breaks between the tasks.

Working Memory Tests and SPMT of Production and Comprehension were administrated in one session of approximately twenty minutes. All testing sessions were documented by the researcher in hand-written form, while the candidate was responding to each task.

Working Memory Tests were conducted firstly in the session with digit forward part preceding the digit backwards task. In the first part, the examiner read out the sequences and the participant had to repeat them in the same order, while in the digit backwards part the examiner read out sequences that the participant was asked to repeat in reverse order. In both sequences the digits were increasing in difficulty. Both tasks were conducted orally by the examiner and the answers were written down. Each task lasted approximately 5 minutes.

Regarding the SPMT of Production (or Production SPMT), for each picture participants were instructed to describe the picture in a single complete sentence using the given verb. Both active and passive sentences were provoked using the picture stimuli, presenting one at a time. The experimental stimuli were randomly ordered for the presentation of the task. The examiner firstly explained that they will take part in a task with pictures and that every time they would see a picture and a verb underneath it. Then, they were instructed to use the verb presented underneath the picture in order to describe what is happening in the displaying picture. No reference was made regarding the production in active or passive sentence. When a participant did not use the verb given or faced difficulty in providing an answer, the examiner asked "Who is doing what to whom?". For example, for a picture depicting a nurse surprising a patient (see Appendix A), the examiner asked "Who is surprising who?". The task was presented to the participants via a laptop and the answers were written down by the

examiner for each stimuli and participant's answer at the same time that the task was taking place. Its duration was approximately 10 minutes. The SPMT of Production task preceded the one for Comprehension in order to prevent participant bias.

With regard to the SPMT of Comprehension (or Comprehension SPMT), the participants were asked to make a choice between two pictures. In this task, subjects were presented with two pictures at each time, one correct and one misleading with reverse assignment of thematic roles, which were accompanied by a spoken test sentence by the examiner. The examiner firstly explained that this task included pictures which would be presented in a set of two each time with the pictures being numbered under every displaying image. Then the examiner explained to the participant that they would hear a sentence from the examiner and they needed to choose the picture that corresponded to the sentence they heard. Every time the participants were presented with a new set of pictures, the examiner asked them "Which picture corresponds to the sentence you heard?". The experimental stimuli were randomly ordered for the administration of the task. The task was presented to the participants via a laptop and the answers were written down by the examiner for each stimulus and corresponding answer at the same time that the task was taking place. Its duration was approximately 8-10 minutes.

All responses were scored as correct or incorrect after the completion of all tasks. Self-correction of the participants was accepted, when made before moving on another question/stimulus. Since naming objects/people is impaired with the onset of Alzheimer's disease, as mentioned in Chapter 2, there were many answers in the SPMT for Production Task that didn't involve the targeted naming of nouns, but involved synonyms, such as "boy" instead of "youngster", and descriptions of where the person was in the picture demonstrated, meaning that they used phrases such as "the right one" and "the left one" or "the person in front" and "the woman in the back". In both cases, as long as the assignment of the role was correct, naming abilities were not taken into account for the purposes of this study.

5.5 Analysis

For the statistical analysis, I followed the instructions given by Field A. (2009). The sample variables of interest were tested for their normality in every population

subgroup. The metrics used were Skewness and Kurtosis as well as the Kolmogorov-Smirnov and Shapiro-Wilk tests for normality.

Most of the variables follow the normal distribution quite consistently despite the data being slightly skewed or kurtotic. However, there is a respectable number of variables that are not normally distributed for some population subgroups (for instance the SPMT of Production for the AD moderate group). Therefore, non-parametric statistical tests were chosen to answer this study's questions. The SPSS version used for this statistical analysis was the SPSS 21.0.

CHAPTER 6
RESULTS OF THE PRESENT STUDY

In this chapter, the results of the statistical analysis are presented aiming to answer the research questions of this study. Descriptive statistics of each group's average on scores of every task are available in the Appendix B (Tables (9) & (10)).

6.1 Normality Test

In order to select the appropriate statistical tests to conduct the statistical analysis of the performance of the population, it is important to test whether the scores are normally distributed. A false assumption might lead to results that are misleading and therefore, compromise this study's conclusions.

All data collected from the performance assessments were put through the Kolmogorov-Smirnoff and Shapiro-Wilk tests for normality. These tests showed that in many cases the data followed a normal distribution. However, there is a respectable number of variables that are not normally distributed (see Appendix B). Therefore, non-parametric statistical tests, like the Mann-Whitney and the Kruskal-Wallis tests, were chosen in order to ensure impartiality in the final results.

6.2 Question (1): Is there a deficit in the mapping between syntactic and semantic representations in psych verbs in populations with MCI and AD?

In order to answer to the first question of this study regarding the existence of linguistic deficit between semantic and syntactic representations, the Mann-Whitney Test was used for the comparison of the three groups, one with MCI and two with AD, with their control groups accordingly. The comparison was made for their performance in the SPMT for Production and the SPMT for Comprehension. In Table 4, the results of the comparison between all participants with MCI and AD and all healthy individuals as controls are listed in detail.

When compared to the healthy population group, scores of population with MCI and AD vary significantly according to Mann-Whitney test statistics. All of the tests indicate p values below the significant level of 0.05, which means that the null hypothesis of equal performance is rejected.

Table 4

Mann-Whitney test statistics for the population with MCI and AD and healthy population group comparisons

	Mann-Whitney U	Z	p
Production SPMT	117.500	-8.195	0.000
Comprehension SPMT	211.500	-7.608	0.000
Production_SPMT_Psychological_Verbs	141.000	-8.053	0.000
Production_SPMT_NonPsychological_Verbs	705.000	-4.505	0.000
Comprehension_SPMT_Psychological_Verbs	211.500	-7.615	0.000
Comprehension_SPMT_NonPsychological_Verbs	446.500	-6.162	0.000
Production_SPMT_Psychological_Frequent_Verbs	564.000	-5.438	0.000
Production_SPMT_Psychological_Rare_Verbs	141.000	-8.075	0.000
Production_SPMT_Nonpsych_Frequent_Verbs	963.500	-2.517	0.012
Production_SPMT_Nonpsych_Rare_Verbs	728.500	-4.347	0.000

Comprehension_SPMT_Psychological_Frequent_Verbs	587.500	-5.275	0.000
Comprehension_SPMT_Psychological_Rare_Verbs	235.000	-7.478	0.000
Comprehension_SPMT_Nonpsych_Frequent_Verbs	634.500	-4.977	0.000
Comprehension_SPMT_Nonpsych_Rare_Verbs	564.000	-5.428	0.000
Production_SPMT_Active_Voice	238.000	-7.343	0.000
Production_SPMT_Passive_Voice	305.500	-7.038	0.000
Production_SPMT_Active_Voice_Psych_Verbs	211.500	-7.635	0.000
Production_SPMT_Active_Voice_NonPsych_Verbs	822.500	-3.680	0.000
Production_SPMT_Passive_Voice_Psych_Verbs	352.500	-6.756	0.000
Production_SPMT_Passive_Voice_NonPsych_Verbs	775.500	-4.023	0.000
Comprehension_SPMT_Active_Voice	211.500	-7.618	0.000
Comprehension_SPMT_Passive_voice	352.500	-6.743	0.000
Comprehension_SPMT_Active_Voice_Psych_Verbs	258.500	-7.334	0.000
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	564.000	-5.432	0.000
Comprehension_SPMT_Passive_Voice_Psych_Verbs	446.500	-6.167	0.000
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	611.000	-5.127	0.000

Note. The labels "NonPsychological" and "NonPsych" are used for the Agent-verbs examined

Furthermore, comparisons between each group with MCI and AD and its respective control group were conducted. Listed in table 5 are the test statistic values that were extracted by comparing the performance between the MCI group and its control group. The groups' scores differ significantly, at a first glance, in their Production SMPT (U=40, z=-4.908, p=0.000) and Comprehension SPMT scores (U=70, z=-4.234, p=0.000). This is evident in most of the variables according to the test statistic values and their significance. However, the MCI population's scores seem to be closer to their healthy control group scores, because there are more conditions of the test that their score does not vary significantly. Those variables are Production SPMT Non-Psychological Verbs (U=190, z=-1, p=0.317), Production SPMT Non-Psychological

frequent verbs (U=200, z=0, p=1.0), Production SPMT Non-Psychological rare verbs (U=180, z=-1.433, p=0.152), Production SPMT Non-Psychological frequent verbs (U=200, z=0, p=1.0), Comprehension SPMT Non-Psychological frequent verbs (U=170, z=-1.777, p=0.076), Production SPMT Active voice Non-Psychological Verbs (U=200, z=0, p=1), Production SPMT Passive voice Non-Psychological Verbs (U=180, z=-1.433, p=0.152) and Comprehension SPMT Passive voice Non-Psychological Verbs (U=170, z=-1.777, p=0.076). Average % scores of the MCI population group are also demonstrated in Figure 1.

Table 5

Mann-Whitney test statistics for the MCI - MCI control group comparison

	Mann-Whitney U	Z	p
Production SPMT	40.000	-4.908	0.000
Comprehension SPMT	70.000	-4.234	0.000
Production_SPMT_Psychological_Verbs	50.000	-4.685	0.000
Production_SPMT_NonPsychological_Verbs	190.000	-1.000	0.317
Comprehension_SPMT_Psychological_Verbs	70.000	-4.238	0.000
Comprehension_SPMT_NonPsychological_Verbs	150.000	-2.355	0.019
Production_SPMT_Psychological_Frequent_Verbs	150.000	-2.355	0.019
Production_SPMT_Psychological_Rare_Verbs	50.000	-4.733	0.000
Production_SPMT_Nonpsych_Frequent_Verbs	200.000	0.000	1.000
Production_SPMT_Nonpsych_Rare_Verbs	180.000	-1.433	0.152
Comprehension_SPMT_Psychological_Frequent_Verbs	140.000	-2.615	0.009
Comprehension_SPMT_Psychological_Rare_Verbs	90.000	-3.790	0.000
Comprehension_SPMT_Nonpsych_Frequent_Verbs	170.000	-1.777	0.076
Comprehension_SPMT_Nonpsych_Rare_Verbs	150.000	-2.357	0.018
Production_SPMT_Active_Voice	75.500	-3.891	0.000
Production_SPMT_Passive_Voice	110.000	-3.346	0.001
Production_SPMT_Active_Voice_Psych_Verbs	60.000	-4.466	0.000

Production_SPMT_Active_Voice_NonPsych_Verbs	200.000	.000	1.000
Production_SPMT_Passive_Voice_Psych_Verbs	120.000	-3.108	0.002
Production_SPMT_Passive_Voice_NonPsych_Verbs	180.000	-1.433	0.152
Comprehension_SPMT_Active_Voice	80.000	-4.029	0.000
Comprehension_SPMT_Passive_voice	110.000	-3.340	0.001
Comprehension_SPMT_Active_Voice_Psych_Verbs	100.000	-3.574	0.000
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	140.000	-2.619	0.009
Comprehension_SPMT_Passive_Voice_Psych_Verbs	130.000	-2.865	0.004
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	170.000	-1.777	0.076

Note. The labels "NonPsychological" and "NonPsych" are used for the Agent-verbs examined.

Table 6 contains the results derived by comparing the performance between the AD mild group and its control group. There is a considerable difference in performance in overall scores of the groups in the Production SPMT (U=8, z=-4.913, p=0.000) and Comprehension SPMT (U=16, z=-4.665, p=0.000) parts of the test. The "Production SPMT Passive Voice Non-Psychological verbs" variable is the only one that does not showcase statistically significant differences in score for those groups (U=24, z=-1.437, p=0.151).

Table 6

Mann-Whitney test statistics for the AD mild - AD mild control group comparison

	Mann-Whitney U	z	p
Production SPMT	8.000	-4.913	0.000
Comprehension SPMT	16.000	-4.665	0.000
Production_SPMT_Psychological_Verbs	8.000	-4.934	0.000
Production_SPMT_NonPsychological_Verbs	88.000	-2.386	0.017
Comprehension_SPMT_Psychological_Verbs	16.000	-4.671	0.000

Comprehension_SPMT_NonPsychological_Verbs	32.000	-4.183	0.000
Production_SPMT_Psychological_Frequent_Verbs	64.000	-3.190	0.001
Production_SPMT_Psychological_Rare_Verbs	8.000	-4.919	0.000
Production_SPMT_Nonpsych_Frequent_Verbs	96.000	-2.104	0.035
Production_SPMT_Nonpsych_Rare_Verbs	96.000	-2.101	0.036
Comprehension_SPMT_Psychological_Frequent_Verbs	80.000	-2.660	0.008
Comprehension_SPMT_Psychological_Rare_Verbs	8.000	-4.931	0.000
Comprehension_SPMT_Nonpsych_Frequent_Verbs	56.000	-3.441	0.001
Comprehension_SPMT_Nonpsych_Rare_Verbs	72.000	-2.923	0.003
Production_SPMT_Active_Voice	24.000	-4.429	0.000
Production_SPMT_Passive_Voice	16.000	-4.702	0.000
Production_SPMT_Active_Voice_Psych_Verbs	24.000	-4.454	0.000
Production_SPMT_Active_Voice_NonPsych_Verbs	88.000	-2.388	0.017
Production_SPMT_Passive_Voice_Psych_Verbs	24.000	-4.472	0.000
Production_SPMT_Passive_Voice_NonPsych_Verbs	112.000	-1.437	0.151
Comprehension_SPMT_Active_Voice	8.000	-4.922	0.000
Comprehension_SPMT_Passive_voice	32.000	-4.175	0.000
Comprehension_SPMT_Active_Voice_Psych_Verbs	8.000	-4.939	0.000
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	64.000	-3.184	0.001
Comprehension_SPMT_Passive_Voice_Psych_Verbs	48.000	-3.687	0.000
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	72.000	-2.935	0.003

Note. The labels "NonPsychological" and "NonPsych" are used for the Agent-verbs examined

Moreover, Table 7 contains the results derived by comparing the performance between the AD moderate group and its control group. Again, the group comparison leads to statistically significant differences in both the Production SPMT (U=0, z=-4.264, p=0.000) and Comprehension SPMT (U=0, z=-4.259, p=0.000) parts of the test. Only

in terms of the "Production SPMT Non-Psychological frequent verbs" variable are the groups of seemingly similar performance, although the z and p values are relatively close to their statistical levels of significance of -1.96 and 0.05 respectively (U=24, z=-1.449, p=0.147). In all other parts of the assessment the groups perform distinctively different according to the Mann-Whitney test.

Table 7

Mann-Whitney test statistics for the AD moderate - AD moderate control group comparison

	Mann-Whitney U	Z	P
Production SPMT	0.000	-4.264	0.000
Comprehension SPMT	0.000	-4.259	0.000
Production_SPMT_Psychological_Verbs	0.000	-4.276	0.000
Production_SPMT_NonPsychological_Verbs	0.000	-4.278	0.000
Comprehension_SPMT_Psychological_Verbs	0.000	-4.255	0.000
Comprehension_SPMT_NonPsychological_Verbs	0.000	-4.255	0.000
Production_SPMT_Psychological_Frequent_Verbs	5.500	-3.993	0.000
Production_SPMT_Psychological_Rare_Verbs	0.000	-4.324	0.000
Production_SPMT_Nonpsych_Frequent_Verbs	49.500	-1.449	0.147
Production_SPMT_Nonpsych_Rare_Verbs	5.500	-3.976	0.000
Comprehension_SPMT_Psychological_Frequent_Verbs	5.500	-3.957	0.000
Comprehension_SPMT_Psychological_Rare_Verbs	0.000	-4.266	0.000
Comprehension_SPMT_Nonpsych_Frequent_Verbs	16.500	-3.370	0.001
Comprehension_SPMT_Nonpsych_Rare_Verbs	0.000	-4.266	0.000
Production_SPMT_Active_Voice	0.000	-4.276	0.000
Production_SPMT_Passive_Voice	0.000	-4.294	0.000
Production_SPMT_Active_Voice_Psych_Verbs	0.000	-4.280	0.000
Production_SPMT_Active_Voice_NonPsych_Verbs	22.000	-3.083	0.002
Production_SPMT_Passive_Voice_Psych_Verbs	0.000	-4.330	0.000

Production_SPMT_Passive_Voice_NonPsych_Verbs	5.500	-4.021	0.000
Comprehension_SPMT_Active_Voice	0.000	-4.270	0.000
Comprehension_SPMT_Passive_voice	0.000	-4.259	0.000
Comprehension_SPMT_Active_Voice_Psych_Verbs	0.000	-4.297	0.000
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	11.000	-3.657	0.000
Comprehension_SPMT_Passive_Voice_Psych_Verbs	0.000	-4.280	0.000
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	0.000	-4.267	0.000

Note. The labels "NonPsychological" and "NonPsych" are used for the Agent-verbs examined

Figures (1), (3), and (5) are illustrating the on average % scores of the overall performance of MCI, AD mild and AD moderate population groups and performance in terms of psych and non-psych verbs.

Figures (2), (4) and (6) are depicting the on average % of the performance of MCI, AD mild and AD moderate population groups in terms of Active and Passive Voice.

Finally, Figure (7) is demonstrating the performance of the healthy group (control group) at ceiling effect.

Figure 1.
Average % scores of the overall performance of MCI population group and performance in terms of psych and non-psych verbs
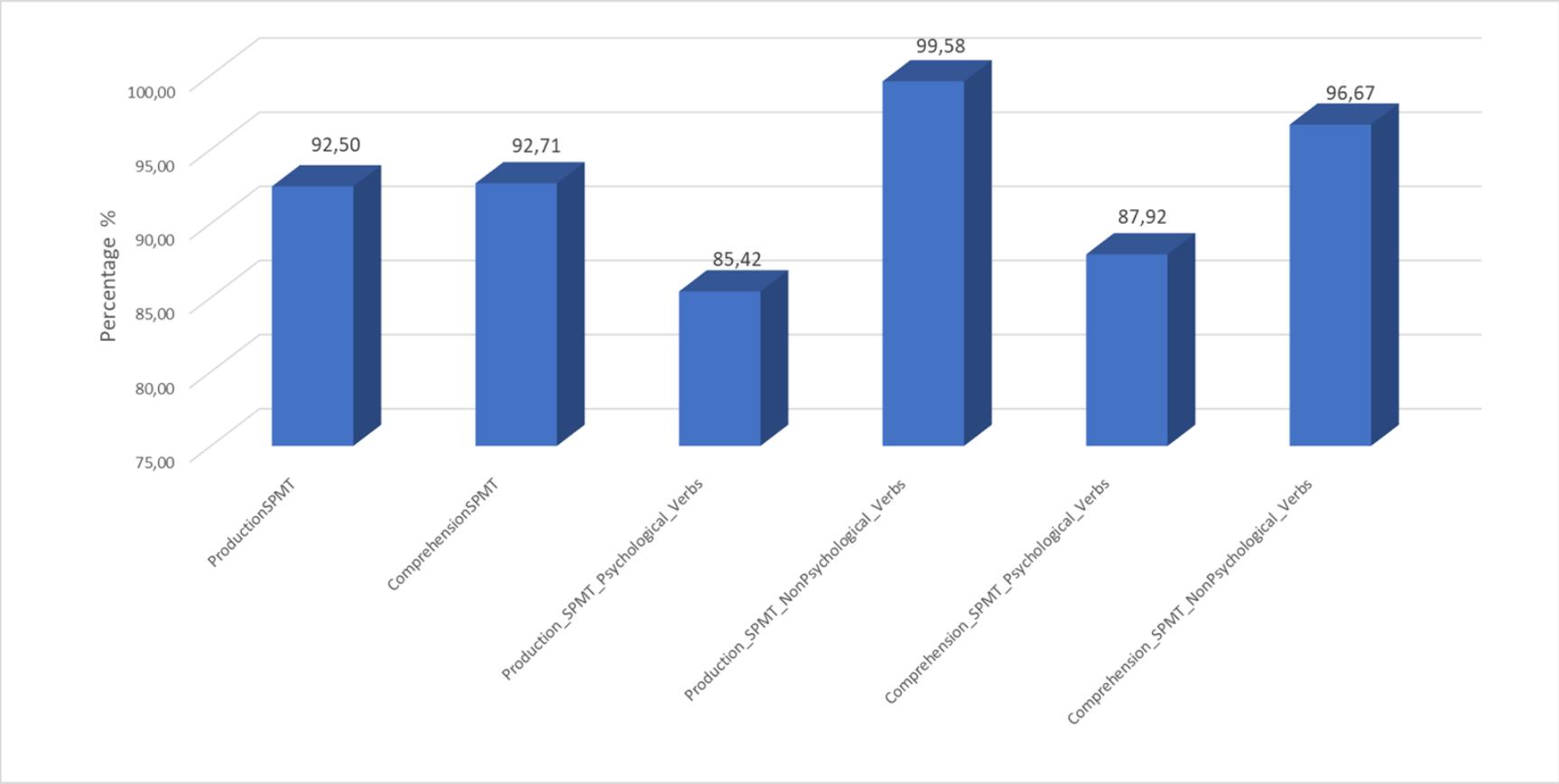
Figure 2.

Average % scores of the performance of the MCI population group in terms of Voice
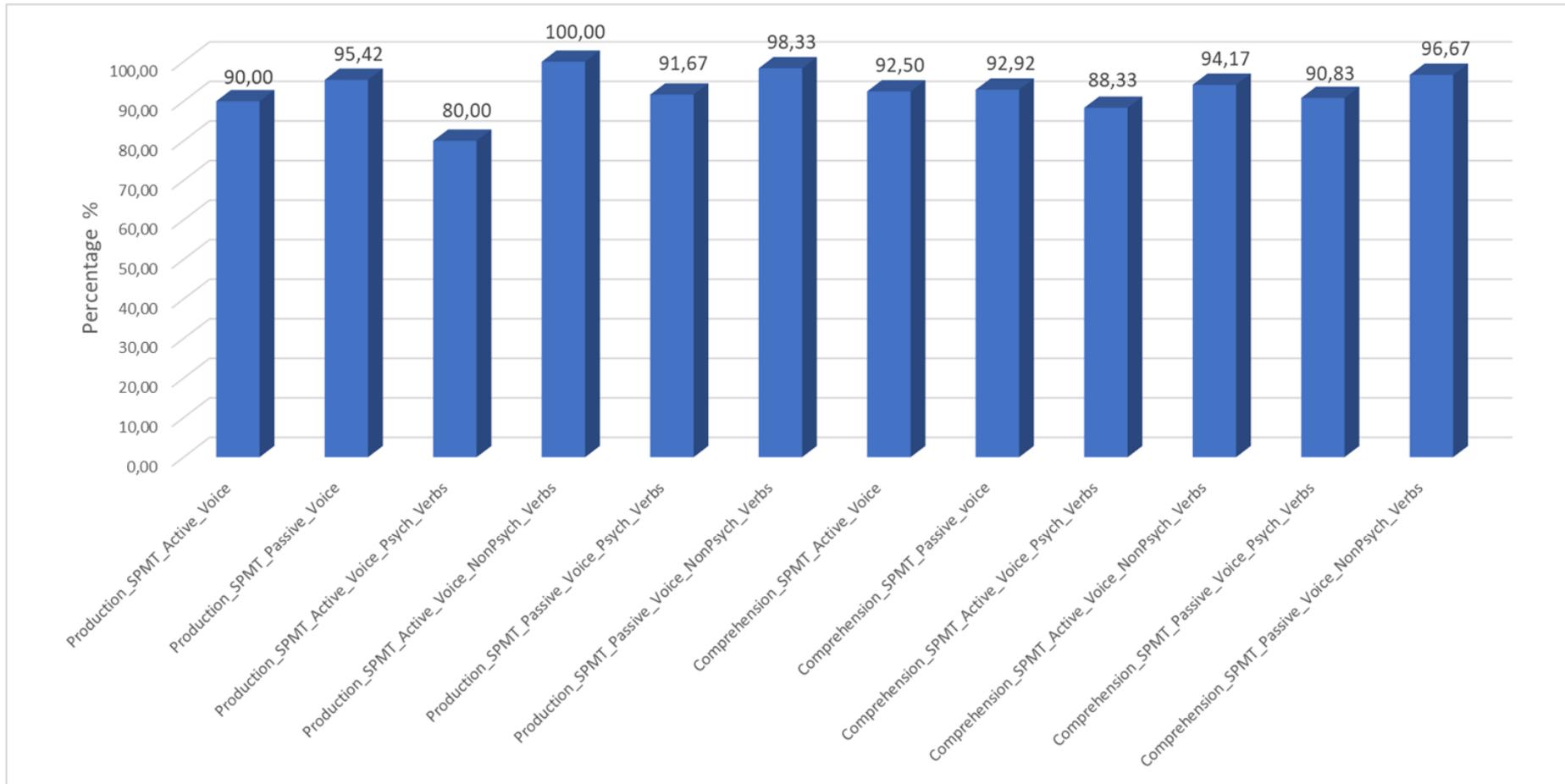
Figure 3.
Average % scores of the overall performance of AD mild population group and in terms of psych and non-psych verbs
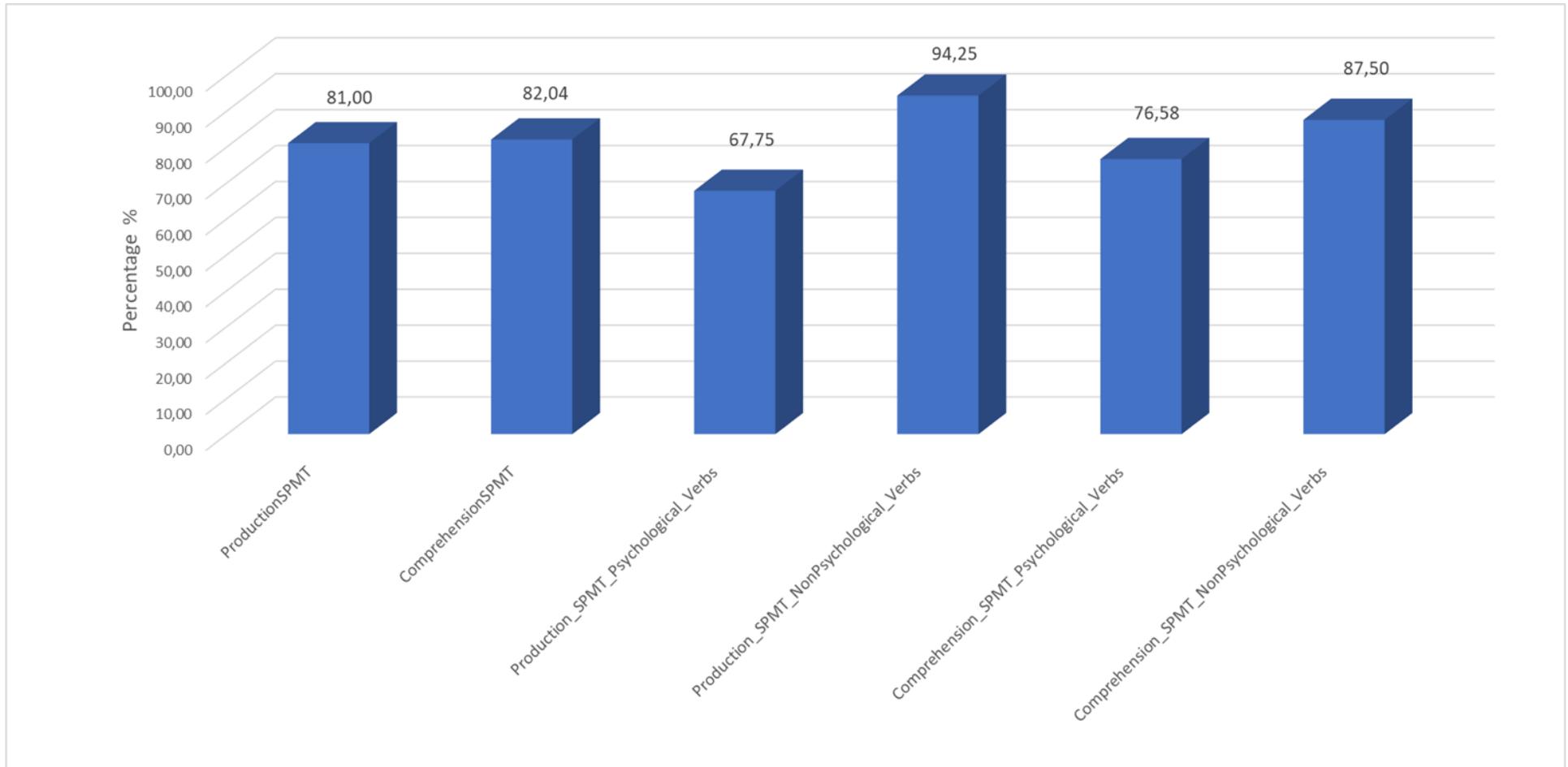
Figure 4.

Average % scores of the performance of the AD mild population group in terms of Voice
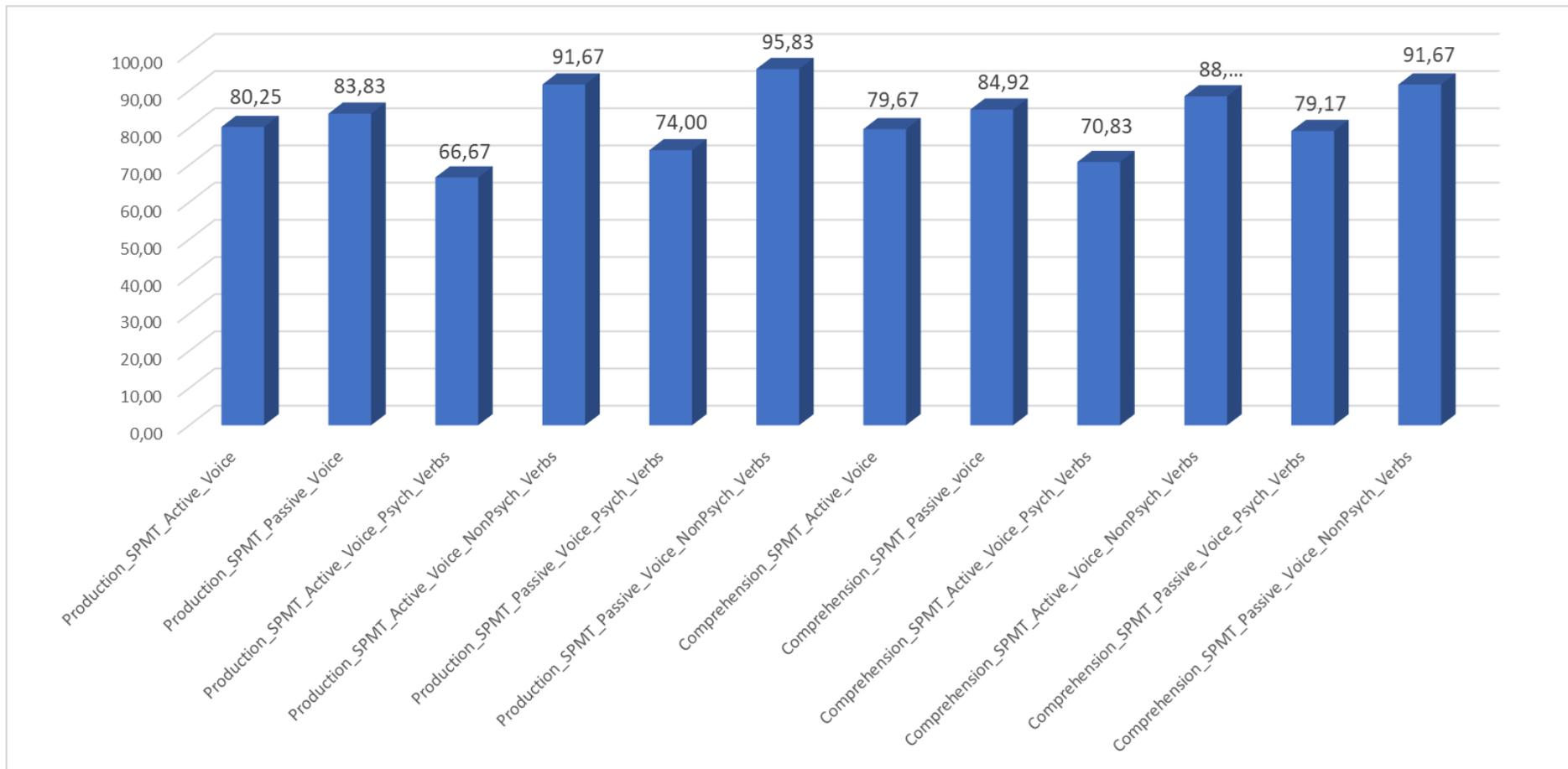
Figure 5.

Average % scores of the overall performance of AD moderate population group and in terms of psych and non-psych verbs
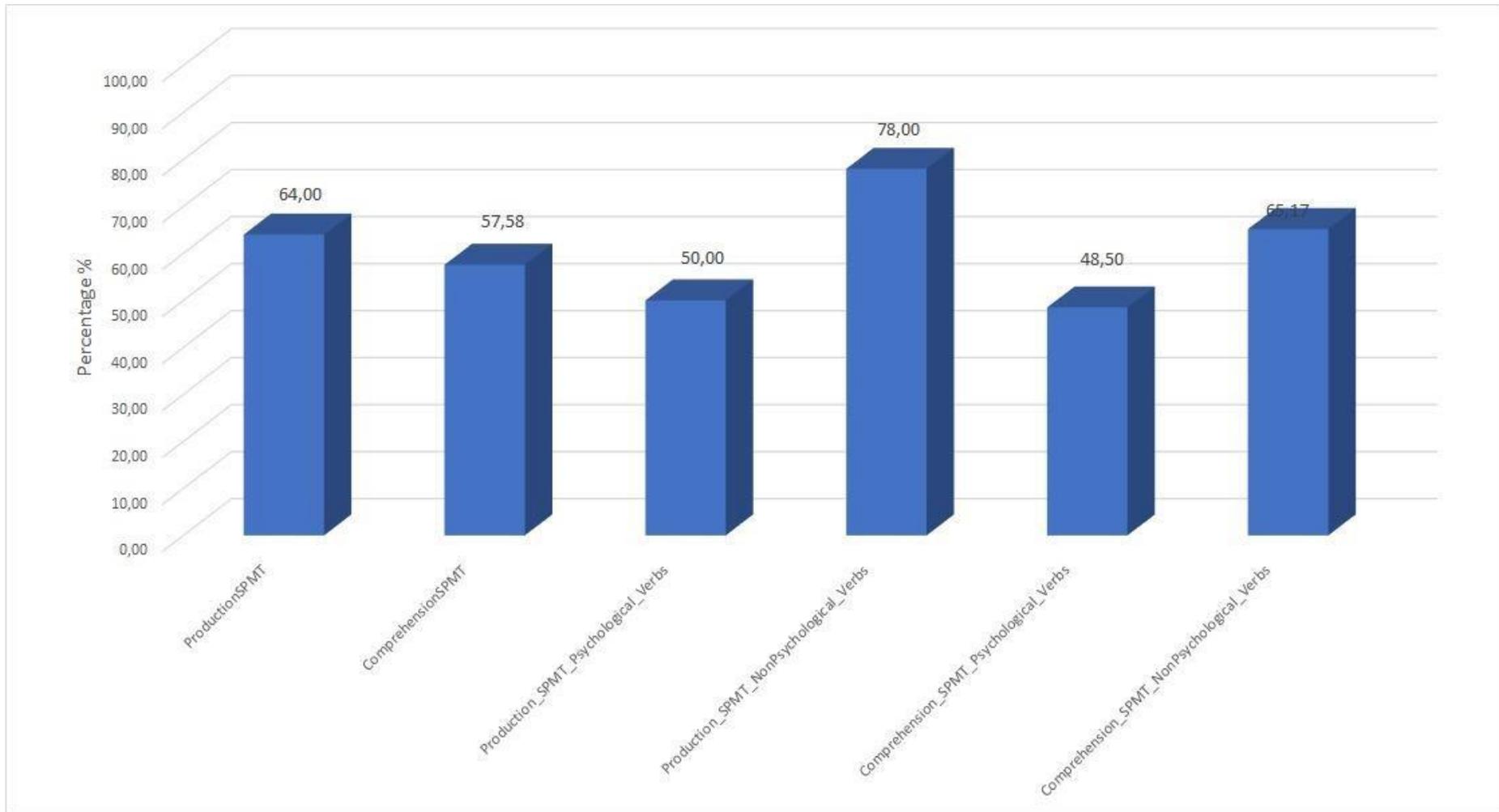
Figure 6. *Average % scores of the performance of the AD mild population group in terms of Voice*
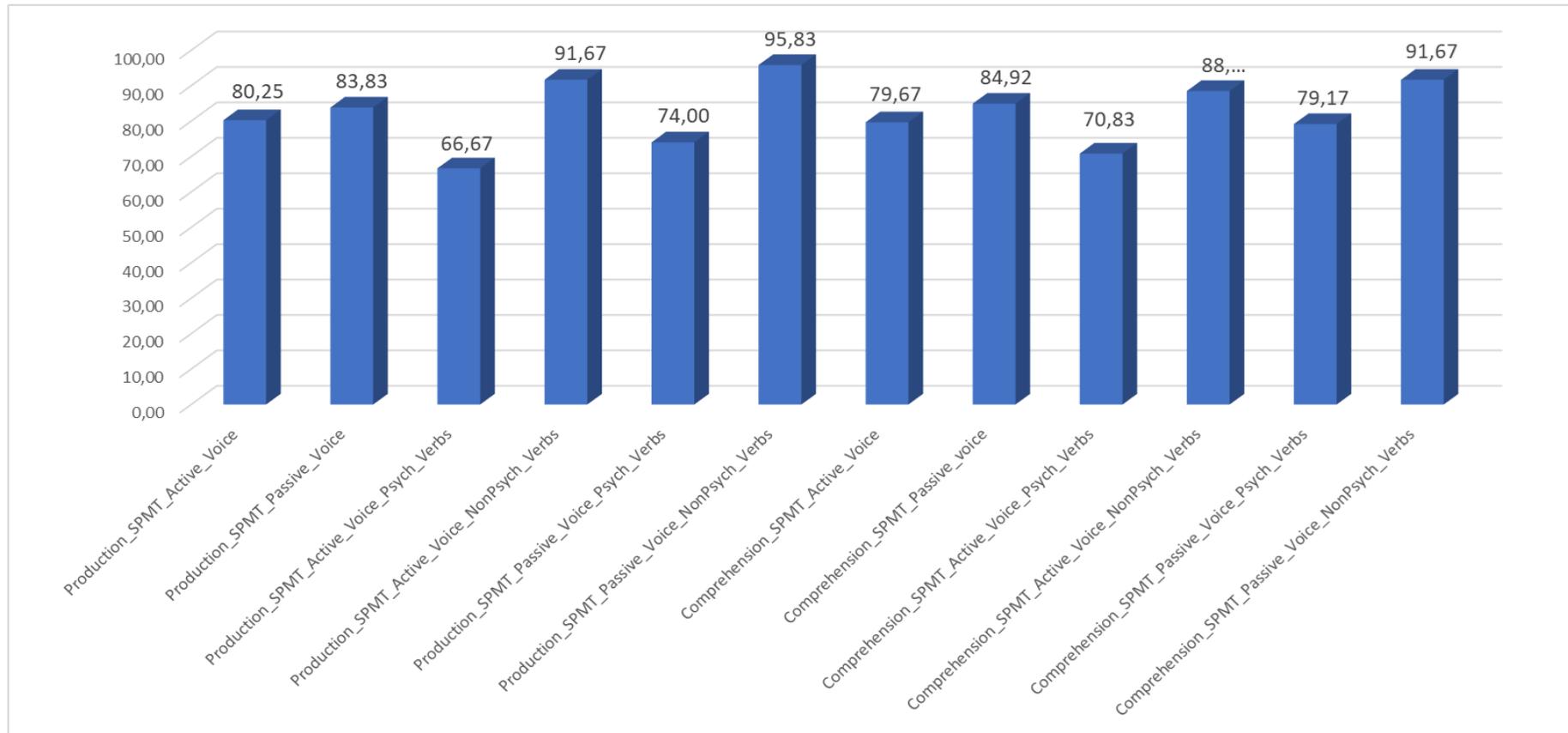
Figure 7.

Average % for the healthy population group (Control group)
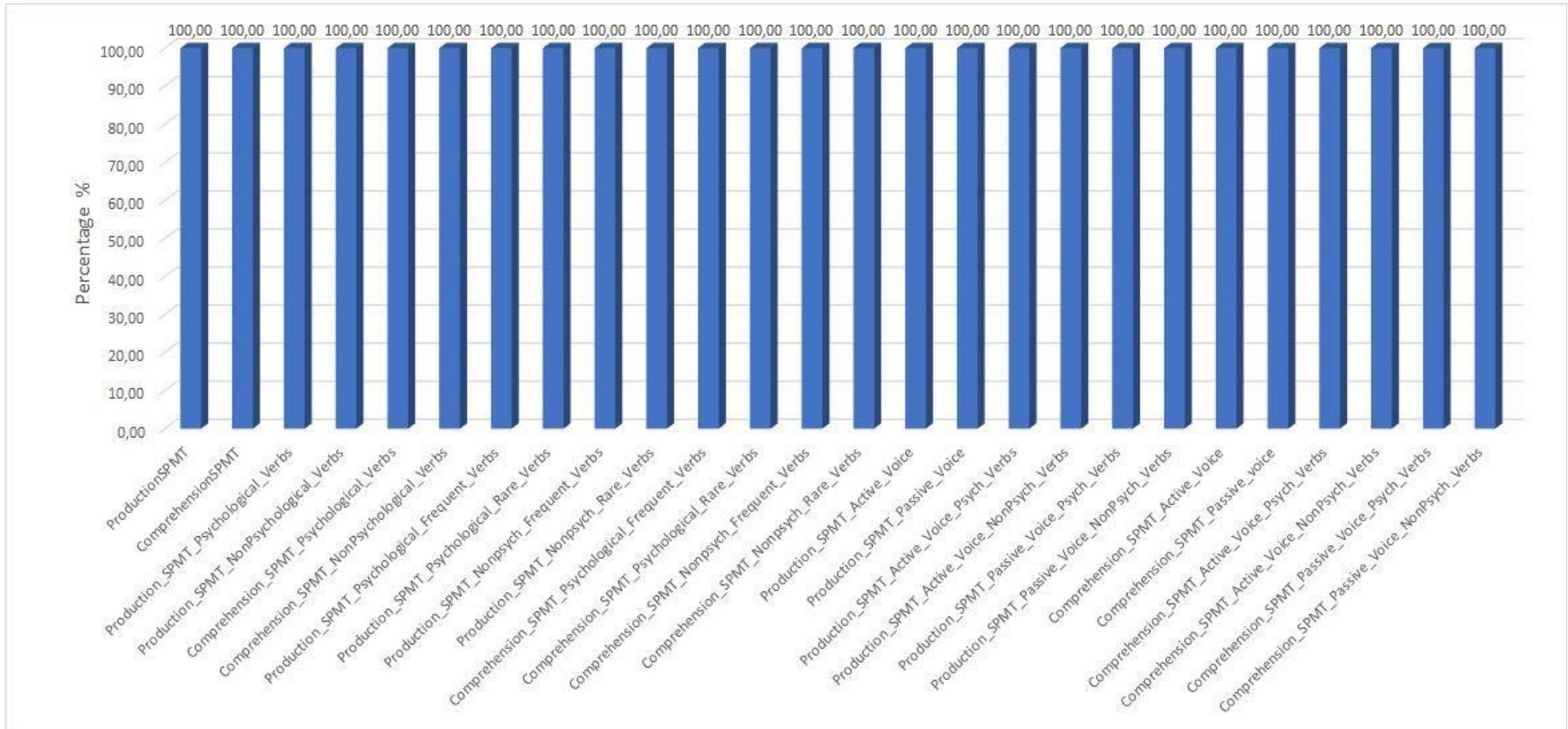
6.3 Question (2): Is the performance of people with MCI and AD getting worse as the disease progresses?

The Kruskal-Wallis test was used for assessing the inter-comparison of groups with MCI and AD in order to detect whether the progress of the language deficit is in alignment with the progress of the disease. Table 8 depicts the overall results of the inter-comparisons, as analyzed in this section.

Patient groups perform differently in their Production SPMT assessment (H(2)=29.118, p=0.000). More specifically, there are statistically significant pairwise differences in performance between all the patient groups. In detail, the Kruskal-Wallis tests for AD mild and AD moderate groups indicate a value of H(1)=13.881 (p=0.028) and the AD moderate and MCI groups and the MCI and AD mild group comparisons indicate values of H(1)=27.243 (p=0.000) and H(1)= 13.362, p=0.010), respectively.

The Kruskal-Wallis test reveals differences in performance among the patient groups in their Production SPMT Psychological verbs assessment (H(2)=27.057, p=0.000). There are statistically significant differences in performance between the AD moderate and MCI groups (H(1)=26.014, p=0.000) and the AD mild and MCI groups (H(1)=13.4, p=0.010). Contradictorily, the AD moderate and AD mild groups appear to perform similarly in that test (H(1)=12.614, p=0.053).

In their Production SPMT Non-Psychological verbs assessment the patient groups showcase differences in performance (H(2)=28.258, p=0.000). There are statistically significant differences between the AD moderate and AD mild groups (H(1)=17.040, p=0.001) and the AD moderate and MCI groups (H(1)=23.327, p=0.000). Contradictorily, the MCI and AD mild groups appear to perform quite similarly (H(1)=6.288, p=0.332).

In their Comprehension SPMT Psychological verbs assessment the patient groups showcase differences in performance (H(2)=23.946, p=0.000). There are statistically significant differences between the AD moderate and AD mild groups (H(1)=15.659, p=0.009) and the AD moderate and MCI groups (H(1)=24.859, p=0.000). Again, the MCI and AD mild groups are of similar average score (H(1)=9.2, p=0.128).

In their Comprehension SPMT Non-Psychological verbs test the patient groups present the same behavior (H(2)=27.515, p=0.000). There are statistically significant

differences between the AD moderate and AD mild groups (H(1)=15.384, p=0.008) and the AD moderate and MCI groups (H(1)=25.827, p=0.000). Again, the MCI and AD mild groups are of similar average score (H(1)=10.444, p=0.053), although the test statistic is very close to rejecting the null hypothesis of equal averages.

In their Production SPMT Psychological frequent and rare verbs assessment the groups with MCI and AD showcase differences in performance (H(2)=15.866, p=0.000 and H(2)=21.46, p=0.000 respectively). In their frequent verbs test responses, the AD moderate and AD mild groups (H(1)=12.818, p=0.027) and the AD moderate and MCI groups (H(1)=18.693, p=0.000) present distinct differences. However, the MCI and AD mild groups appear to be of similar average score (H(1)=5.875, p=0.485). In their rare verbs test responses, the results are slightly different. The AD mild – MCI and AD moderate – MCI comparisons are of statistically significant difference (H(1)=13.731, p=0.006 and H(1)=22.007, p=0.000 respectively), with the AD mild and AD moderate groups being of very close performance (H(1)=8.276, p=0.338).

In the Production SPMT Non-Psychological frequent verbs assessment the groups perform similarly across the board (H(2)=5.067, p=0.079). However, in the respective rare verbs assessment the test statistic reveals statistically significant differences (H(2)=24.796, p=0.000). The AD mild – AD moderate and AD moderate – MCI comparisons are of statistically significant difference (H(1)=17.597, p=0.000 and H(1)=20.959, p=0.000 respectively), with the AD mild and AD moderate groups being of very close performance (H(1)=3.362, p=1.0).

In their Comprehension SPMT Psychological frequent verbs assessment the groups with MCI and AD showcase differences in performance (H(2)=15.742, p=0.000). Those differences are more evident between the AD moderate and AD mild groups (H(1)=16.216, p=0.003) and the AD moderate and MCI groups (H(1)=17.791, p=0.000). In contrast, the MCI and AD mild groups are of similar average score (H(1)=1.575, p=1.0). For the respective rare verbs test, the statistical analysis depicts a similar pattern in the groups inter-comparison (H(2)=21.472, p=0.000). The AD moderate and AD mild (H(1)=13.5, p=0.031) and the AD moderate and MCI group pairwise comparisons (H(1)=23.275, p=0.000) show that those groups have differences in performance. Once more, the MCI and AD mild groups perform similarly (H(1)=9.775, p=0.09).

In their Comprehension SPMT Non-Psychological frequent verbs assessment the groups with MCI and AD present statistically significant differences in performance (H(2)=12.019, p=0.002). The differences are met only between the AD moderate and MCI groups (H(1)=15.220, p=0.003). The MCI - AD mild and AD mild – AD moderate group pairwise comparisons show non-significant performance differences (H(1)=9.144, p=0.077 and H(1)=6.077, p=0.612). For the respective rare verbs test, the groups' inter-comparison also reveals performance differences (H(2)=20.852, p=0.000). The AD moderate and AD mild (H(1)=16.667, p=0.002) and the AD moderate and MCI group pairwise comparisons (H(1)=21.373, p=0.000) show that those groups have differences in performance. Again, the MCI and AD mild groups perform very similarly (H(1)=4.694, p=0.804).

In active voice verbs of the Production SPMT test, the groups with MCI and AD differ in performance (H(2)=20.808, p=0.000). Pairwise, the AD mild – AD moderate groups and AD moderate and MCI groups are the ones with significant differences (H(1)=12.824, p=0.046 and H(1)=22.961, p=0.000). AD mild and MCI group do not deviate from each other according to the test statistic (H(1)=10.138, p=0.075), although it is very close in rejecting the null hypothesis of similar performance. In the passive voice verbs of the same test, all groups' scores are statistically different both in their inter-comparison (H(2)=31.125, p=0.000)), as well as in their pairwise comparisons. The Kruskal-Wallis test statistic for the AD mild - AD moderate is H(1)=14.338 (p=0.019), for the AD moderate - MCI is H(1)=27.732 (p=0.000) and for the AD mild - MCI is H(1)=13.394 (p=0.009).

Groups with MCI and AD perform differently in their Production SPMT Psychological Active voice verbs test (H(2)=18.059, p=0.000). More specifically, there are statistically significant pairwise differences in performance between AD mild and AD moderate groups (H(1)=12.631, p=0.036) and the AD moderate and MCI groups (H(1)=21.193, p=0.000). The MCI and AD mild group comparison test statistics indicate a value of H(1)= 8.562 (p=0.165), which reveals a non-significant difference. Moving over to the Non-Psychological active voice verbs for Production SPMT, the Kruskal-Wallis test reveals statistically significant differences in the group inter-comparison (H(2)=14.338, p=0.001) . Those differences are focused in the AD-moderate-MCI comparison with a test statistic of H(1)=14.591 (p=0.001). Both the AD

mild -AD moderate and AD mild-MCI pairwise comparisons lead to non-significant differences (H(1)=6.997, p=0.264 and H(1)=7.594, p=0.092, respectively).

In terms of Passive voice Psychological verbs in the Production SPMT assessment, the overall scores diverge in-between the groups according to the statistical analysis (H(2)=27.048, p=0.000). This is evident across all pairwise comparisons. The test statistic for the AD mild-AD moderate group comparison is H(1)=13.67 (p=0.025) and for the AD moderate – MCI group comparison H(1)=25.595 (p=0.000). The output value for the AD mild -MCI comparison is H(1)=11.925 (p=0.022). The equivalent non-Psychological verbs test, also, reveals a difference in performance (H(2)=24.836, p=0.000) which is more noticeable in the pairwise comparisons between the AD mild and AD moderate and the AD moderate and MCI groups (H(1)=18.33, p=0.000 and H(1)=19.305, p=0.000, respectively).AD mild and MCI groups perform very similarly and this is depicted by the very low statistic value of H(1)=0.975 (p=1.000).

Splitting the Comprehension SPMT test into passive and active voice verb responses, the results are again very interesting. The Active voice verbs score varies a lot in all group comparisons according to the statistical analysis (H(2)=30.611, p=0.000). Pairwise comparisons confirm this divergence with the test statistic values being H(1)=15.943 (p=0.008) for the AD mild-AD moderate groups, H(1)=27.943 (p=0.000) for the AD moderate - MCI groups and H(1)=12 (p=0.025) for AD mild – MCI groups. The Passive voice verbs test, also, reveals a statistically significant difference in the performance of the patient groups (H(2)=23.017, p=0.000). The pairwise comparisons locate those differences in the AD mild – AD moderate and the AD moderate – MCI group comparisons (H(1)=16.659, p=0.004 and H(1)=24.059, p=0.000, respectively). In contrast, there is no difference in performance between the AD mild and MCI groups (H(1)=7.400, p=0.298).

The Psychological Active voice verbs score of the Comprehension SPMT assessment differs across the patient groups quite significantly (H(2)=26.924, p=0.000). The null hypothesis is rejected for all pairwise comparisons. More specifically, the test statistic for the AD mild - AD moderate group comparison is H(1)=14.562 (p=0.017), for the AD moderate - MCI is H(1)=25.95 (p=0.000) and for the AD mild - MCI is H(1)=11.388 (p=0.034). The equivalent non-Psychological verb test (active voice), although extracting a statistically significant difference in group inter-comparison (H(2)=11.352, p=0.003), this is only confirmed by the AD moderate – MCI group

comparison (H(1)=15.905, p=0.002). The other pairwise comparisons reveal non-significant performance differences for tor AD mild -AD moderate and the AD mild – MCI groups (H(1)=10.83, p=0.084 and H(1)=5.075, p=0.688, respectively).

In terms of Passive voice Psychological verbs in the Comprehension SPMT assessment, the overall scores differ in-between the groups according to the statistical analysis (H(2)=18.011, p=0.000). The test statistic for the AD mild-AD moderate group comparison is H(1)=12.682 (p=0.040) and for the AD moderate – MCI group comparison H(1)=20.832 (p=0.000). The output value for the AD mild -MCI comparison is H(1)=8.15 (p=0.19), which depicts a non-significant score difference. The equivalent non-Psychological verbs test, also, reveals a difference in performance (H(2)=25.67, p=0.000) which is again more noticeable in the pairwise comparisons between the AD mild - AD moderate and the AD moderate - MCI groups (H(1)=17.875, p=0.001 and H(1)=23.3, p=0.000, respectively). AD mild and MCI groups perform very similarly and this is depicted by the test statistic value of H(1)=5.425 (p=0.575).

Table 8

Kruskal-Wallis test for the inter-comparisons of the three patient groups.

	H	p
Production SPMT	29.198	0.000
Comprehension SPMT	28.179	0.000
Production_SPMT_Psychological_Verbs	27.057	0.000
Production_SPMT_NonPsychological_Verbs	28.258	0.000
Comprehension_SPMT_Psychological_Verbs	23.946	0.000
Comprehension_SPMT_NonPsychological_Verbs	27.515	0.000
Production_SPMT_Psychological_Frequent_Verbs	15.866	0.000
Production_SPMT_Psychological_Rare_Verbs	21.460	0.000
Production_SPMT_Nonpsych_Frequent_Verbs	5.067	0.079
Production_SPMT_Nonpsych_Rare_Verbs	24.956	0.000
Comprehension_SPMT_Psychological_Frequent_Verbs	15.742	0.000
Comprehension_SPMT_Psychological_Rare_Verbs	21.472	0.000
Comprehension_SPMT_Nonpsych_Frequent_Verbs	12.019	0.002
Comprehension_SPMT_Nonpsych_Rare_Verbs	20.852	0.000
Production_SPMT_Active_Voice	20.808	0.000
Production_SPMT_Passive_Voice	31.125	0.000
Production_SPMT_Active_Voice_Psych_Verbs	18.059	0.000
Production_SPMT_Active_Voice_NonPsych_Verbs	14.338	0.001
Production_SPMT_Passive_Voice_Psych_Verbs	27.048	0.000
Production_SPMT_Passive_Voice_NonPsych_Verbs	24.836	0.000

Comprehension_SPMT_Active_Voice	30.611	0.000
Comprehension_SPMT_Passive_voice	23.017	0.000
Comprehension_SPMT_Active_Voice_Psych_Verbs	26.924	0.000
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	11.352	0.003
Comprehension_SPMT_Passive_Voice_Psych_Verbs	18.011	0.000
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	25.670	0.000

Note. The labels "NonPsychological" and "NonPsych" are used for the *Agent*-verbs examined

6.4 Question (3): Does the frequency of the verb's appearance in everyday life play a role in the performance of people with MCI and AD?

The Mann-Whitney Tests used in section (6.2) answer to this research question as well. Tables (4), (5), (6), (7) demonstrate that frequency is statistically significant in most cases of examined data.

Furthermore, in Figures (8), (9) and (10) the different performance of the MCI, AD mild and AD moderate is demonstrated respectively. All three groups perform evidently better when they deal with frequent psychological verbs in both the production and comprehension tasks, than with the rare ones. What is remarkable, is the similar performance of all groups for non-psychological verbs independently of frequency.

Figure 8.

Average % scores of the performance of the MCI population group in terms of frequency
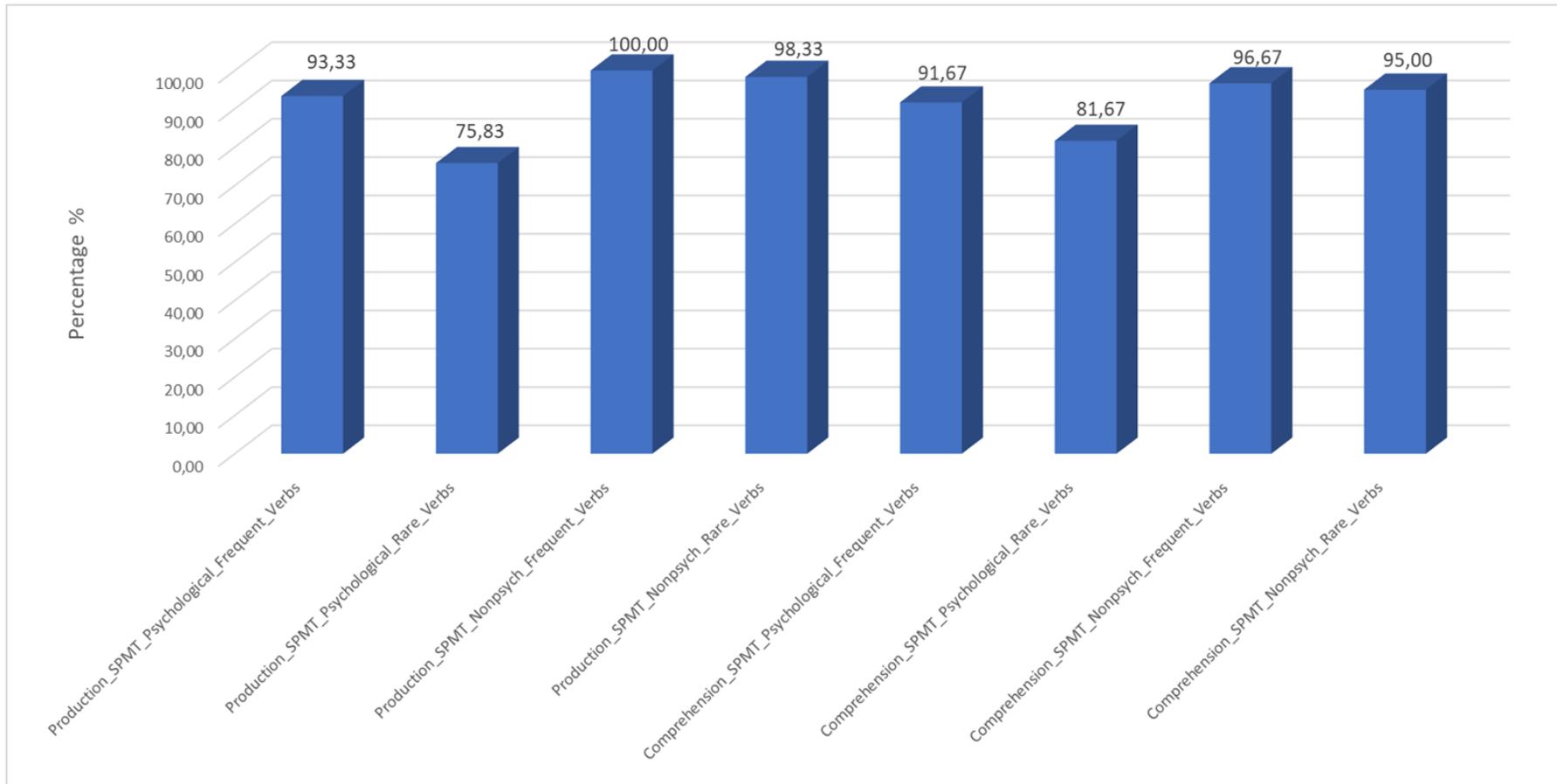
Figure 9.

Average % scores of the performance of the AD mild population group in terms of frequency
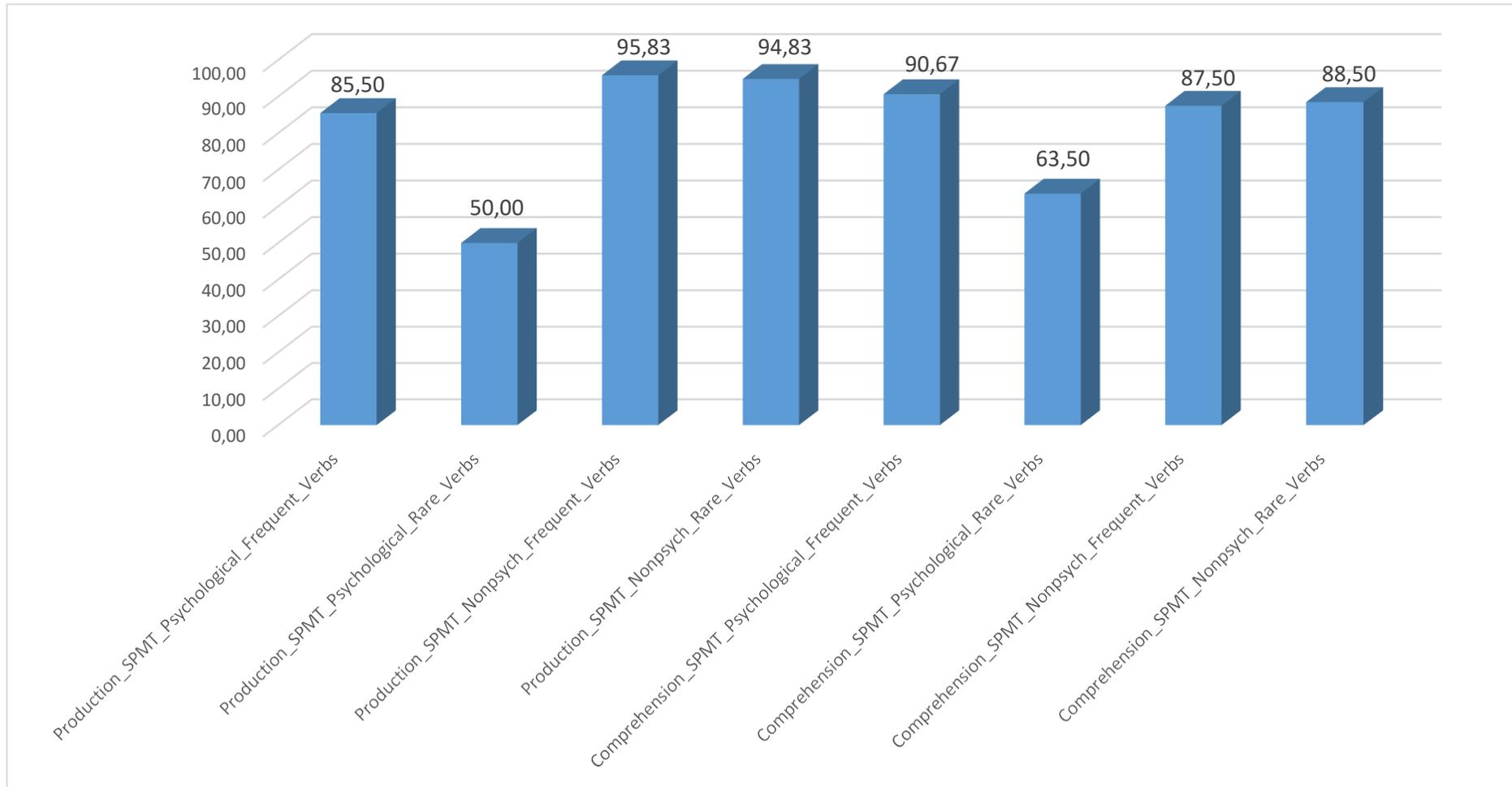
Figure 10.

Average % scores of the performance of the AD moderate population group in terms of frequency
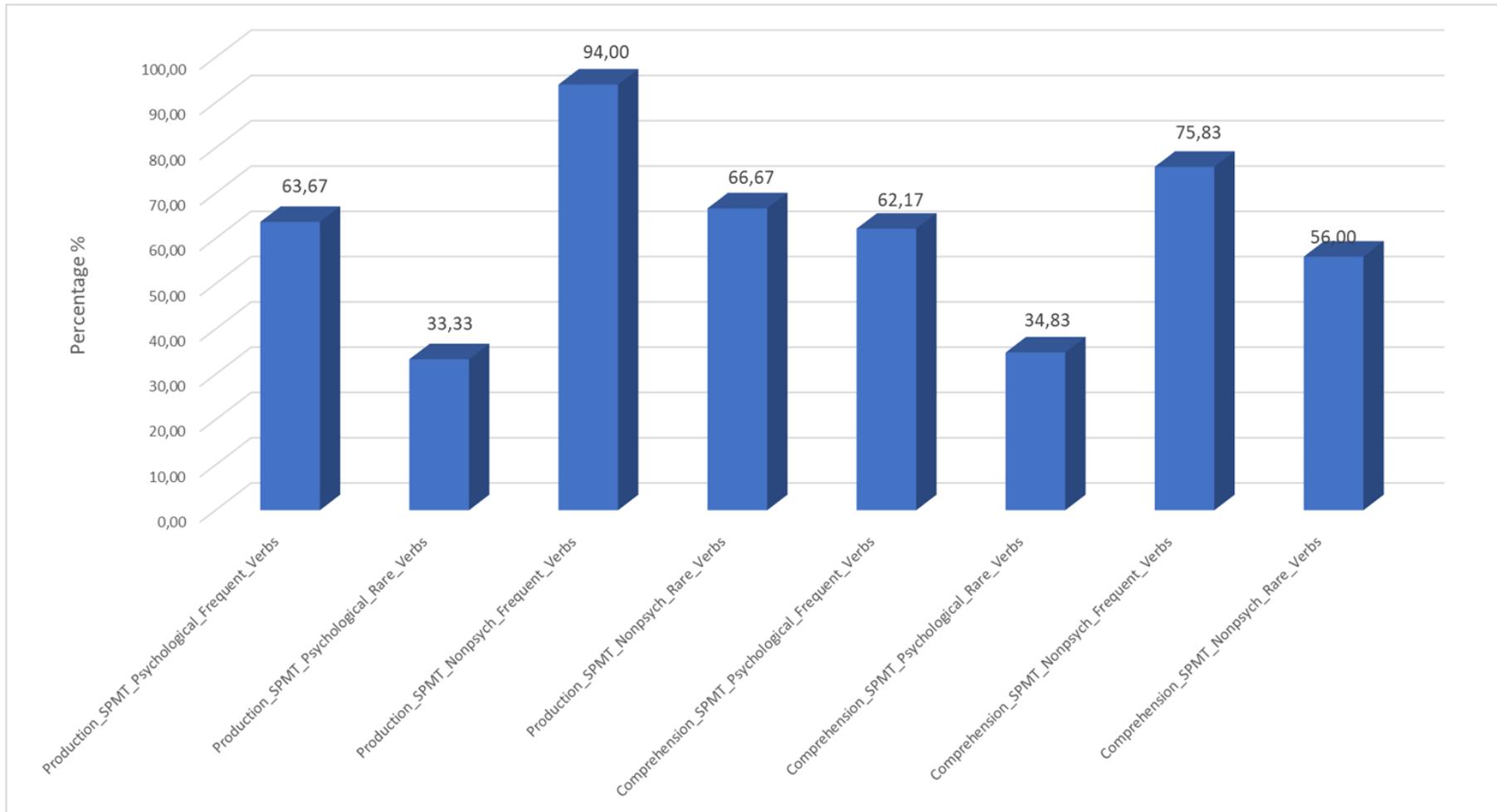
6.5 Question (4): Are the linguistic difficulties of the population with MCI and AD related to Working Memory Capacity?

The correlation coefficients of the Working memory tests and the Production and Comprehension test variables are listed in table 9, in detail. The coefficient values indicate a medium-level correlation of the aforementioned variables. Most notably, the correlation coefficients of the variables for the Comprehension SPMT Psychological verbs with the Working memory test indicate the strongest correlations ($\rho=0.452$ for the first test and $\rho=0.519$ for the second). Interestingly enough, the second working memory test appear to better correlate with the Production part of the test. This is evident in variables such as the Production SPMT Passive voice verbs ($\rho=0.577$), Production SPMT Passive voice verbs ($\rho=0.526$) and Production SPMT Passive voice Psychological verbs ($\rho=0.610$). Some of the comprehension SPMT test variables also show stronger correlations with the second working memory test. For instance, Comprehension SPMT Active voice verbs ($\rho=0.542$), Comprehension SPMT Passive voice verbs ($\rho=0.509$), Comprehension SPMT Active voice Psychological verbs ($\rho=0.496$) and Comprehension SPMT Passive voice non-Psychological verbs ($\rho=0.595$).

Table 9

Spearman correlation coefficients of the Working memory tests with the Production and Comprehension test variables

	WM Score 1	WM Score 2
Production_SPMT	0.395	0.556
Comprehension_SPMT	0.400	0.563
Production_SPMT_Psychological_Verbs	0.381	0.530
Production_SPMT_NonPsychological_Verbs	0.319	0.469
Comprehension_SPMT_Psychological_Verbs	0.452	0.519
Comprehension_SPMT_NonPsychological_Verbs	0.393	0.503
Production_SPMT_Psychological_Frequent_Verbs	0.265	0.206
Production_SPMT_Psychological_Rare_Verbs	0.410	0.436
Production_SPMT_Nonpsych_Frequent_Verbs	0.150	0.142
Production_SPMT_Nonpsych_Rare_Verbs	0.216	0.412

Comprehension_SPMT_Psychological_Frequent_Verbs	0.292	0.345
Comprehension_SPMT_Psychological_Rare_Verbs	0.516	0.469
Comprehension_SPMT_Nonpsych_Frequent_Verbs	0.218	0.255
Comprehension_SPMT_Nonpsych_Rare_Verbs	0.505	0.496
Production_SPMT_Active_Voice	0.342	0.526
Production_SPMT_Passive_Voice	0.484	0.577
Production_SPMT_Active_Voice_Psych_Verbs	0.307	0.453
Production_SPMT_Active_Voice_NonPsych_Verbs	0.240	0.417
Production_SPMT_Passive_Voice_Psych_Verbs	0.459	0.610
Production_SPMT_Passive_Voice_NonPsych_Verbs	0.248	0.302
Comprehension_SPMT_Active_Voice	0.389	0.542
Comprehension_SPMT_Passive_voice	0.319	0.509
Comprehension_SPMT_Active_Voice_Psych_Verbs	0.359	0.496
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	0.362	0.361
Comprehension_SPMT_Passive_Voice_Psych_Verbs	0.240	0.385
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	0.340	0.595

Note. The labels "NonPsychological" and "NonPsych" are used for the Agent-verbs examined and WM Score 1 = Digit forwards task, WM Score 2 = Digit backwards task

Furthermore, attempting to investigate Working Memory, a part of Memory, correlation of language tasks and the RAVLT and RMBT Tasks was examined. The results showed that there is strong correlation between them, as Table (10) & (11) demonstrate.

Table 10

Spearman correlation coefficient results between the RAVLT, Production and Comprehension variables

	RAVLT Συνολο	RAVLT Άμεσης Λεκτικής Μάθησης	RAVLT Καθυστερημένης Λεκτικής Μάθησης
Production_SPMT	0.736	0.576	0.066
Comprehension_SPMT	0.721	0.635	0.049

Table 11

Spearman correlation coefficient results between the RMBT, Production and Comprehension variables

	RMBT1 AA	RMBT2 KA
Production_SPMT	0.709	0.735
Comprehension_SPMT	0.690	0.686

CHAPTER 7

Discussion & Conclusion

This chapter aims to provide answers regarding the research questions presented in Chapter 5, based on the statistical analysis conducted in Chapter 6. The interpretation of the statistical results will be focused on main points leading to the explanation of the linguistic deficit addressed.

7.1 Question (1): Is there a deficit in the mapping between syntactic and semantic representations in psych verbs in populations with MCI and AD?

In order to answer the first question concerning the presence of a semantic-syntactic impairment in populations with MCI and AD, I start with comparing the three different groups with their control groups. The first observation made confirms the hypothesis that populations with MCI and AD performs worse than healthy elderly people.

Firstly, the MCI Group performed well in both the Production (92.5%) and the Comprehension SPMT (92.7%), but not as well as its Control Group, which is at ceiling effect (see Figure 4). The participants with MCI faced particular difficulty with assigning θ-roles in psychological verbs in both tasks and in both cases of Subject-*Experiencer* verbs (constructions in Passive Voice) and Object-*Experiencer* verbs (construction in Active Voice). However, they performed differently between tasks, meaning that in the Production SPMT they are more impaired with the mapping of the *Experiencer* onto the Object, while in the Comprehension SPMT they performed similarly with the controls regarding this parameter. This finding indicates that the mechanisms responsible for linguistic output, when it deviates from canonical hierarchy, are more sensitive at the level of pre-dementia than the mechanisms working for processing the input of semantic and syntactic properties.

Following, participants with mild AD performed evidently worse than the corresponding healthy participants, as Mann-Whitney comparison test showed.

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Although the overall performance of this group is similar in both Production and Comprehension SPMT, people with AD demonstrate a strong deficit in assigning the *Experiencer* and *Theme* roles in Production. However, they manage to correctly assign the *Agent* role in most cases, meaning that they face difficulty when they deal with a psych verb rather than agentive one. Moreover, in the Comprehension SPMT Object-*Experiencer* instances are observed to demonstrate greater difficulty for people with mild AD due to their complexity in the procedure of mapping between thematic role and syntactic structure. More interestingly, the difference in performance between the cases of psychological verbs and the cases of non-psychological verbs is noticeable, leading to the observation that in the first stage of dementia of Alzheimer type there is greater impairment of the ability to map semantic information on deviations of canonical argument realization.

Lastly, participants with moderate AD faced great difficulty in assigning the θ-roles mainly of the Object- and Subject-*Experiencer*, with scores being lowest in Comprehension SPMT. This could be an indication that comprehension gets worse more easily than production at this stage of the disease. It is remarkable that in terms of Production and frequent non-psych verbs, the AD moderate group performed similarly with the AD mild Group scoring 94% and 95,3% accordingly.

The overall picture of the participants with MCI and AD reveals that thematic role assignment without the *Agent* argument is challenging, a finding that confirms previous work (Manouilidou et al., 2009; Grossman et al, 1998 among others). It seems that both deviations from canonical thematic hierarchy, atypical and non-canonical, create confusion in populations with MCI and AD due to their evident semantic deficit, which has significant impact on the syntax-semantics interface between syntax and semantics. The fact that the deficit is observed in both production and comprehension and in *Experiencer* and *Agent* verbs leads to the observation that the deficit is more a general impairment of mapping semantic participants onto syntactic structures than a limited deficit in specific language procedures, despite the greater sensitivity to complex argument realization (atypical and non-canonical thematic hierarchy). Furthermore, the results of the current study confirm findings of previous studies regarding AD (Grossman et al., 1996) supporting the existence of a common function in the domain of language for the semantic and syntactic processing in comprehension. In addition, the current findings account for a unified function or mechanism

responsible for processing semantic and syntactic properties in production as well, as Altman et al. (2001) and Levelt (1989) proposed.

Lastly, the agreement of results in dementia populations, that speak different languages, English, Italian, Korean, Slovak, and this study in Greek, leads to the enrichment of cross-linguistic research upon language deficits in dementia towards the impairment of verb argument realization.

7.2   Question (2): Does the performance of people with MCI and AD get worse as the disease progresses?

According to the results presented in Chapter 6, overall the severity of the disease influences significantly the domain of language abilities. Differentiation was observed in most cases of MCI and mild AD comparison, except in the case of the Comprehension SPMT, where they performed similarly. Similar performance in the condition of psychological verbs in the Production SPMT as well, reveals that the impairment in these two stages is at the same level regarding this specific condition, but cannot remain stable as the disease progresses. Moreover, in terms of the levels of AD, participants with mild AD and moderate AD performed similarly in the condition of low frequency in psychological verbs when asked to produce them, but demonstrated variation in the Comprehension Task. These findings support that, although generally language abilities decrease as the level of dementia increase, there is not enough distinctness between stages in order to allow, at this point, how the limits are defined regarding the deficit in the semantic-syntactic interface.

7.3   Question (3): Does the frequency of the verb's appearance in everyday life play a role in the performance of people with MCI and AD?

As illustrated in Figures (1), (2) & (3), frequency plays a significant role in the processing of argument realization in all conditions, confirming the hypothesis made. As the level of dementia rises, frequency influences the performance of participants even more, as scores in the condition of rare psychological verbs demonstrate. For example, the population with moderate AD scored 33,3% in Production SPMT and

34,8% in Comprehension SPMT, while the population with mild AD scored 50% in Production SPMT and 63,5% in Comprehension SPMT regarding the low frequency of the input. The decrease of performance is evident when taking into account the performance of MCI as well (75,8% and 81,6% accordingly).

These findings lead to the proposal that the semantic-syntactic deficit could be coped with stable input of semantic concepts mapped into syntactic structures as a training program. People with dementia demonstrate strong learning abilities in the framework of systematicity of input as results of training programs among Day Care facilities.

7.4 Question (4): Are the linguistic difficulties of the population with MCI and AD related to Working Memory Capacity?

Results regarding the relation of linguistic performance and Working Memory Capacity revealed that there is a weak relationship between the two domains of cognitive abilities. This is a finding contradicting previous work (Sung et al., 2013; Small et al., 2000; Furlan, 1994) and also rejecting the hypothesis of this study, except for the fact that the relationship is stronger between the Digit Backwards Task and language performance. This result may be due to the fact that all participants with MCI and AD are attending training programs for their cognitive abilities, for their Memory among others, leading to higher performance than expected.

What is more, trying to examine whether other components of Memory (e.g. episodic, semantic) play a role in language abilities, correlation tests were used for defining the relationship between linguistic performance in terms of verb argument realization and two tasks that assess short-term memory and learning strategies (RAVLT) and episodic, semantic memory and attention (RMBT). The results showed a strong relationship between decreasing language abilities in MCI and AD and the capacity of many components of Memory, short-term, episodic and semantic, a finding that aligns with the explanation of Grossman and White-Devine (1998) regarding the significance of semantic memory in relation to argument structure. This confirms the strong relationship between Language and Memory and provides further evidence that their relationship needs to be narrowed down more efficiently and examined in-depth.

There are some limitations associated with this study that need to be kept in mind when analyzing its findings. First, it is essential for more participants to be examined in order to reach conclusions that depict the language deficit in verb argument structure in Greek. Secondly, it would be advisable to administer the tasks with longer periods of time intervening between the tasks, but due to COVID-19 pandemic that was not an option as the meetings were limited. Moreover, co-examining more components of cognitive abilities with language abilities is a significant necessity for addressing the disease's deficits adequately. An important factor for future research is literacy skills, as receptive and productive skills are fundamental for language processing.

To sum up, the current study demonstrates that verb agreement processing of psychological verbs is compromised in MCI and AD. The agreement involving the *Agent*-role is significantly less problematic than the realization of the *Experiencer* argument. However, impairment in mapping the semantic participants on the syntactic structure is evident, enhancing the deficit known in the semantic domain, while accounting for the existence of a common function that processes the semantic and syntactic properties of the verb. Distinct performance between healthy groups and groups with MCI and AD illustrates that there is difficulty in processing the thematic structure of hierarchies that deviate from the canonical argument realization. This finding that can be perceived as a starting point in establishing the importance of thematic role assignment in the framework of verb semantic deficits. Although the current study provides more information on the linguistic deficit in MCI and AD contributing in understanding how language abilities are affected by dementia, further investigation is essential for narrowing the language impairment and providing rehabilitation activities for maintenance and improvement of the linguistic domain.

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A. Sentence-picture matching Task of Production.

- Object-*Experiencer* frequent psych verbs:

1. Target sentence:

Η γάτα   φοβίζει   το σκύλο.

The cat-F.SG.NOM. frighten-PRS.3SGACT. the dog-M.SG.ACC.

'The dog frightens the cat.
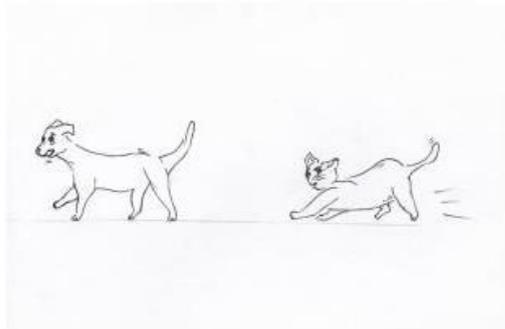
φοβίζω

2. Target sentence:

    Οι κλέφτες   ταράζουν   την κόρη.

    The thief-M.PL.NOM   upset-PRS.3PL.ACT. the daughter-F.SG.ACC.

    'The thieves upset the daughter.'
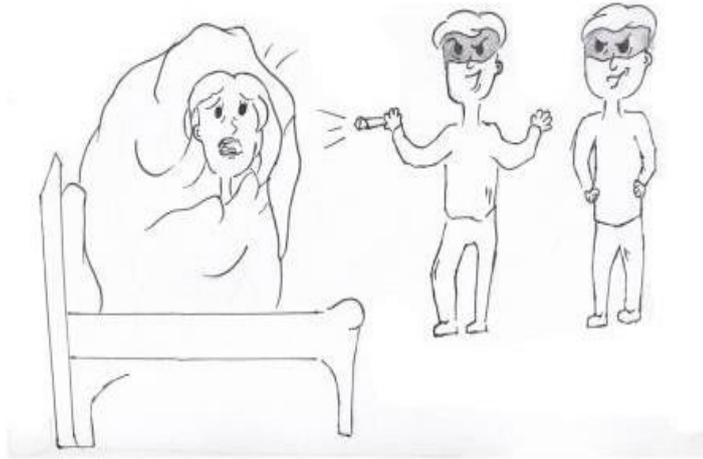
ταράζω

3. Target sentence:

Ο πελάτης   προβληματίζει   την ταμία.

The customer-M.SG.NOM trouble-PRS.3SG.ACT the cashier-F.SG.ACC.

'The customer troubles the cashier.'
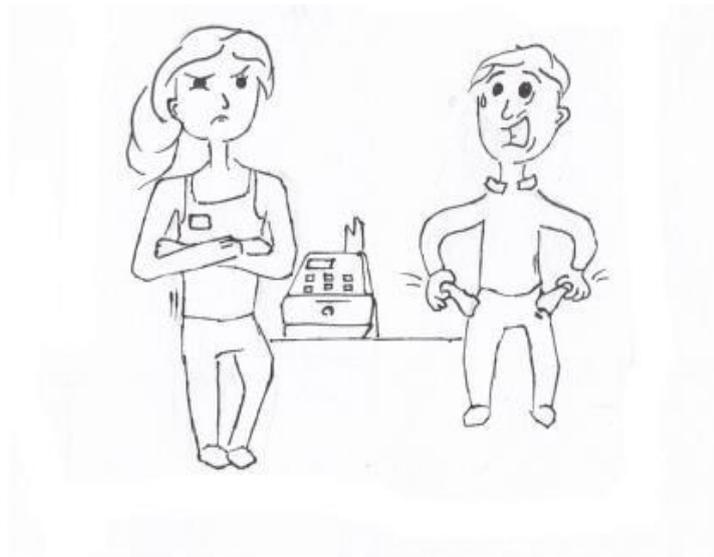
προβληματίζω

- Object-*Experiencer* rare psych verbs:

4. Target Sentence:

Η   νοσοκόμα   ξαφνιάζει   την ασθενή.

The nurse-F.SG.NOM surprise-PRS.3SG ACT. the patient-F.SG.ACC.

'The nurse surprises the patient.'

ξαφνιάζω

5. Target sentence:

Οι εργάτες   τσαντίζουν   τον αγρότη.

The worker- M.PL.NOM enrage-PRS.3PL.ACT. the farmer-M.SG.ACC.

'The works enrage the farmer.'
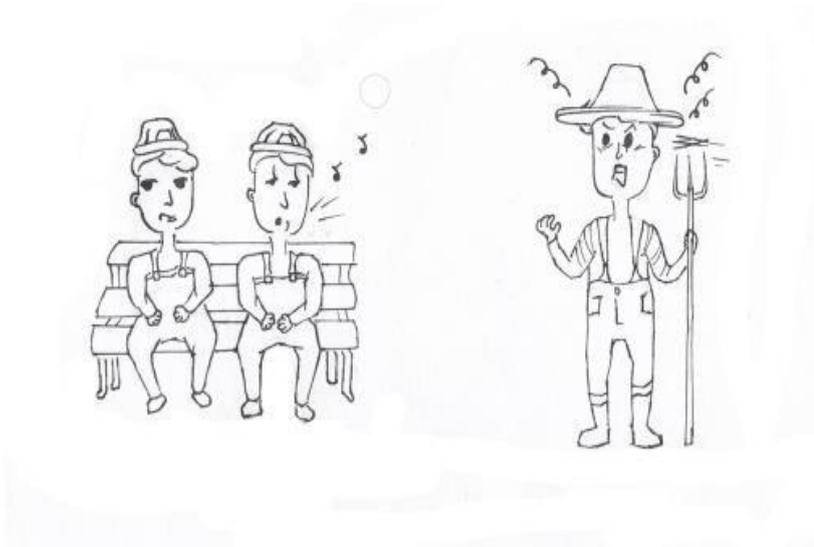
τσαντίζω

6. Target Sentence:

    Η   γάτα   λυπεί   την κοπέλα.

    The cat-F.SG.NOM. make.sad-PRS.3SG.ACT. the girl-F.SG.ACC.

    'The cat makes sad the girl.'
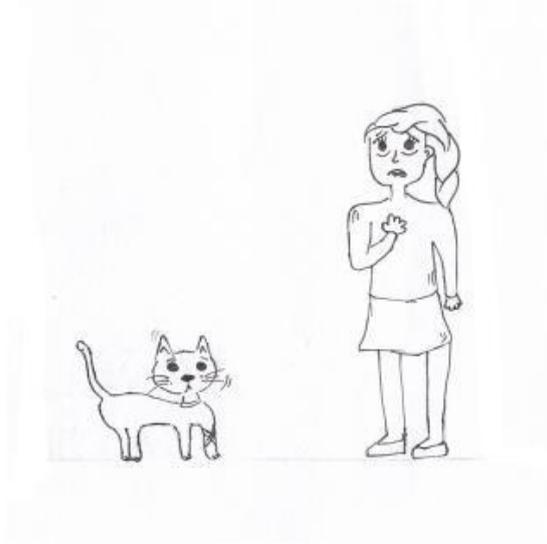
λυπώ

- Subject-*Experiencer* frequent psych verb:

7. Target Sentence:

Η   γάτα   φοβάται   με   το σκύλο.

The cat-F.SG.NOM. frighten-PRS.3SG.PASS. with the dog-M.SG.ACC.

'The cat is frightened by the dog.
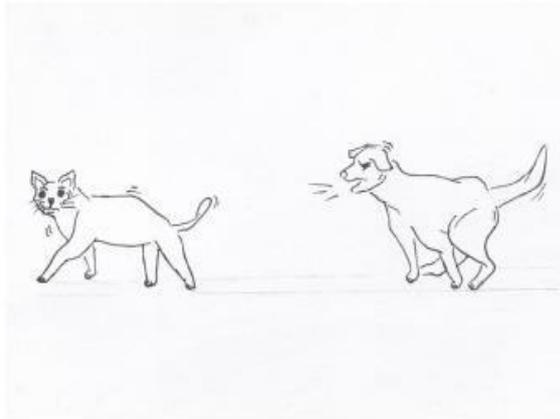
φοβάμαι με

8. Target Sentence:

Η κόρη ταράζεται με τους κλέφτες.

The girl-N.SG.NOM. upset-PRS.3SG.PASS. with the thief-M.SG.ACC.

'The girl gets upset by the thieves.'
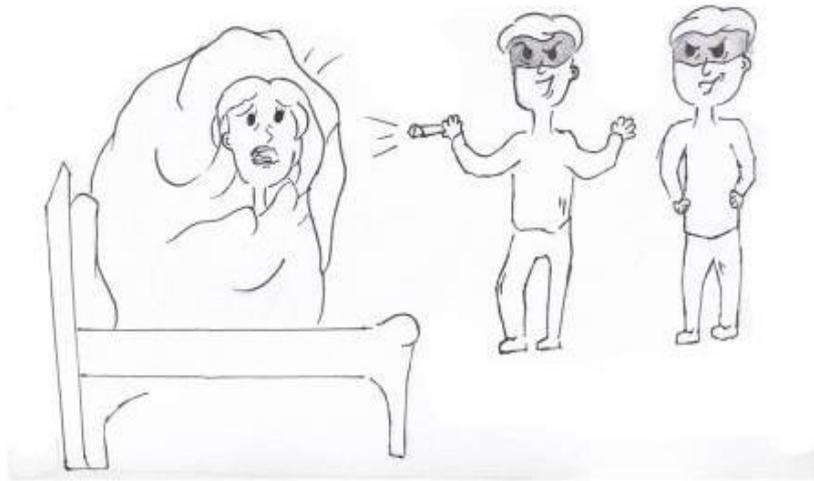
ταράζομαι με

9. Target sentence:

Η ταμίας   προβληματίζεται   με   τον πελάτη.

The cashier-F.SG.NOM. trouble-PRS.3SG.PASS. with the customer-M.SG.ACC.

'The cashier is troubled by the customer.'
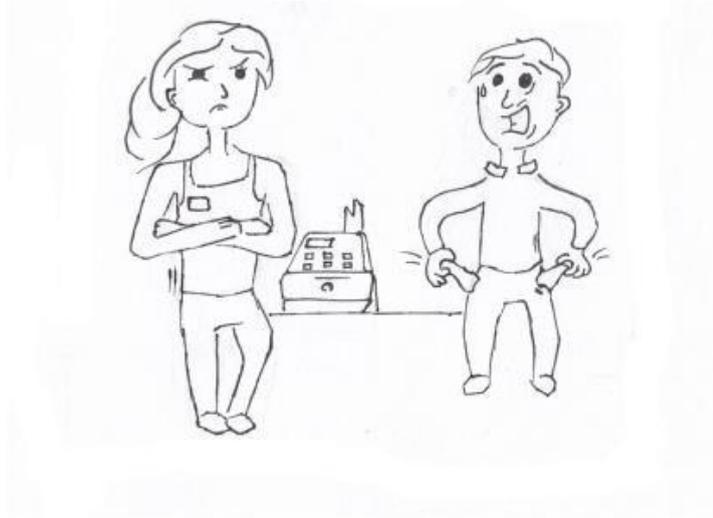
προβληματίζομαι με

- Subject-*Experiencer* rare psych verbs:

10. Target sentence:

Η   ασθενής   ξαφνιάζεται   με   τη νοσοκόμα.

The patient-F.SG.NOM surprise- PRS.3SG.PASS. with the nurse-F.S.ACC.

'The patient is surprised by the nurse.'

ξαφνιάζομαι με

11. Target sentence:

Ο αγρότης τσαντίζεται με τους εργάτες.

The farmer-M.SG.NOM. enrage-PRS.3SG.PASS. with the worker-M.PL.ACC.

'The farmer is enraged by the workers.'
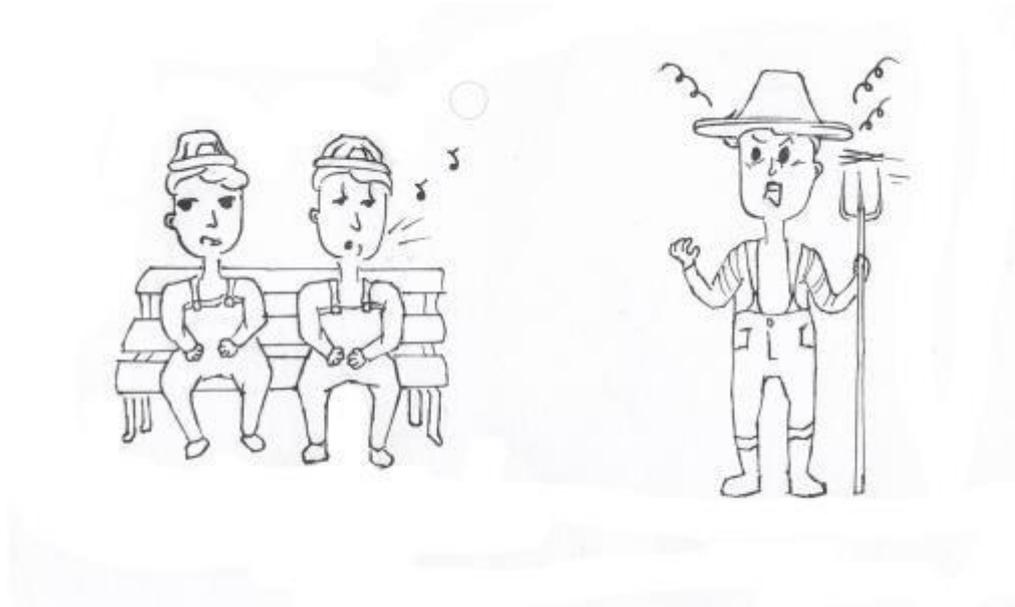
τσαντίζομαι με

12. Target sentence:

Η   κοπέλα   λυπάται   με τη γάτα.

The girl-F.SG.NOM. feel.sad-PRS.3SG.PASS. with the cat-F.SG.ACC.

'The girl feels sad for the cat.'

λυπάμαι με

- Subject-*Agent* frequent non-psych verb:

13. Target sentence:

Ο   ελέφαντας   πατάει   τον άνθρωπο.

The elephant-M.SG.NOM step.on- PRS.3SG.ACT. the human-M.SG.ACC.

'The elephant steps on the human.'
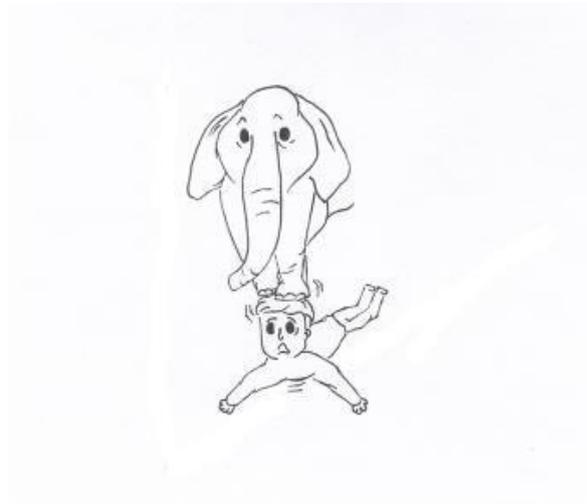
πατάω

14. Target sentence:

Ο   σκύλος   κυνηγάει   τη γάτα.

The dog-M.SG.NOM. chase-PRS.3SG.ACT the cat-F.SG.ACC.

'The dog chases the cat.'
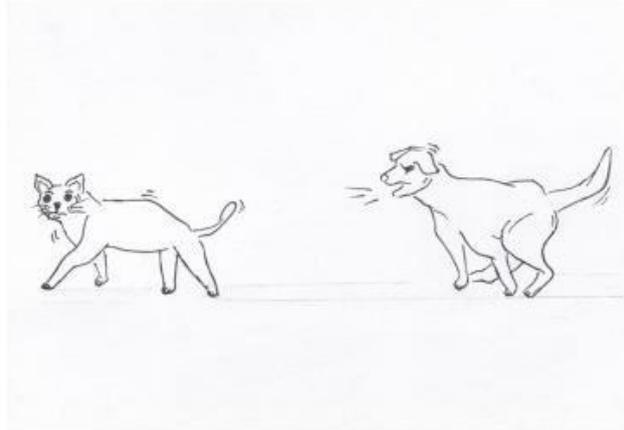
κυνηγάω

15. Target sentence:

Ο   άντρας   σπρώχνει   τη γυναίκα.

The man-M.SG.NOM. push-PRS.3SG.ACT. the woman-F.SG.ACC.

'The man pushes the woman.'

σπρώχνω

- Subject-*Agent* rare non-psych verbs:

16. Target sentence:

Ο   νεαρός   βρέχει   την κοπέλα.

The youngster-M.SG.NOM make.wet- PRS.3SG.ACT the girl-F.SG.ACC.

'The youngster makes wet the girl.'

βρέχω

17. Target sentence:

Η   κοπέλα   κρύβει   το νεαρό.

The girl-F.SG.NOM. hide-PRS.3SG.ACT. the youngster-M.SG.ACC.

'The girl hides the youngster.'

κρύβω

18. Target sentence:

Η   κοπέλα   σκεπάζει   την γιαγιά.

The girl-F.SG.NOM. tuck.in-PRS.3SG.ACT. the grandmother-F.SG.ACC.

'The girl tucks in the grandmother.'

σκεπάζω

- Object-*Agent* (by phrase) frequent non-psych verb:

19. Target Sentence:

Ο άνθρωπος   πατιέται   από   τον ελέφαντα.

The human-M.SG.NOM. step- PRS.3SG.PASS. from   the elephant-M.SG.ACC.

'The human was stepped by the elephant.'
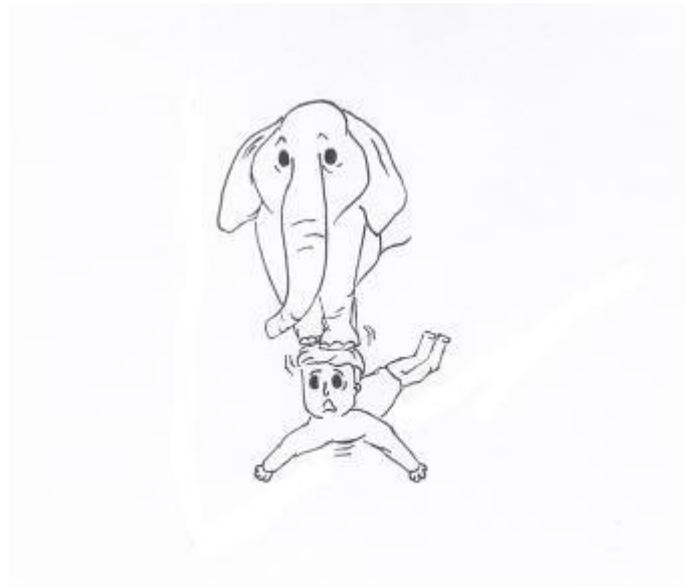
πατιέμαι

20. Target sentence:

Η   γάτα   κυνηγιέται   από το σκύλο.

The cat-F.SG.NOM. chase-PRS.3SG.PASS from the dog-M.SG.ACC.

'The cat is chased by the dog.'
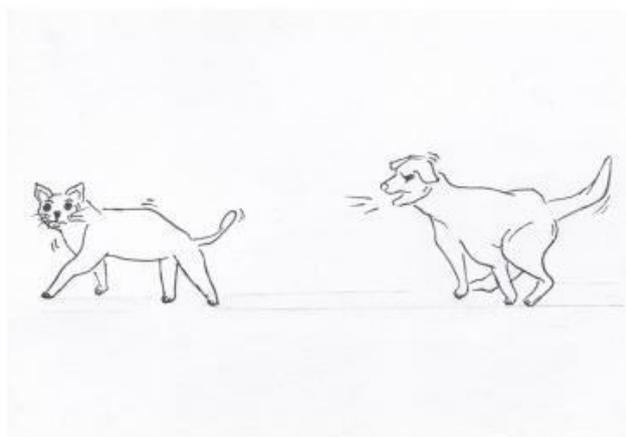
κυνηγιέμαι

21. Target sentence:

Η γυναίκα   σπρώχνεται   από τον άντρα.

The woman-F.SG.NOM. push-PRS.3SG.PASS from the man-M.SG.ACC.

'The woman is pushed by the man.'

σπρώχνομαι

- Object-*Agent* (by phrase) rare non-psych verbs:

22. Target Sentence:

Η   κοπέλα   βρέχεται   από το νεαρό.

The girl-F.SG.NOM. make.wet- PRS.3SG.PASS. from the youngster-M.SG.ACC.

'The girl is made wet by the youngster.'

βρέχομαι

126

23. Target sentence:

Ο   νεαρός   κρύβεται   από την κοπέλα.

The youngster-M.SG.NOM. hide-PRS.3SG.PASS. from the girl-F.SG.ACC.

'The youngster is hidden by the girl.'

κρύβομαι

24. Target sentence:

Η   γιαγιά   σκεπάζεται   από τη   κοπέλα.

The grandmother-F.SG.NOM. tuck.in-PRS.3SG.PASS. from the girl-F.SG.ACC.

'The girl is tucked in by the girl.'

σκεπάζομαι

B. Sentence-picture matching Task for Comprehension.

- Object-*Experiencer* frequent psych verbs:

1. Ο   σκύλος   φοβίζει   τη γάτα.

   The dog-M.SG.NOM. frighten-PRS.3SGACT. the cat-F.SG.ACC.

   'The dog frightens the cat.'
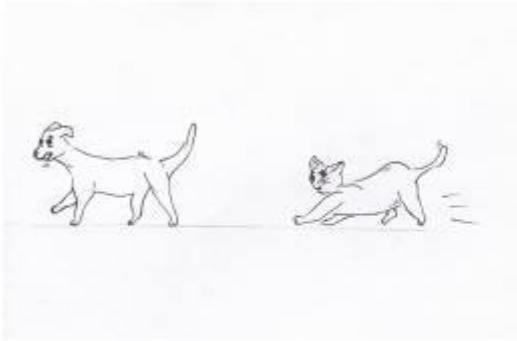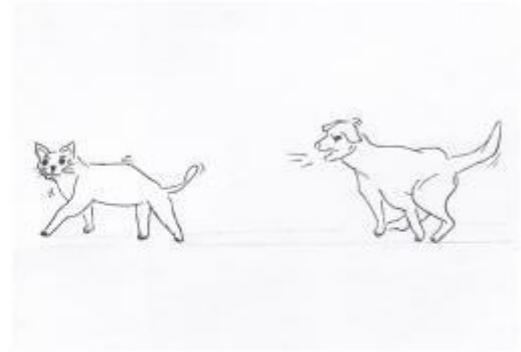
1   2

2. Οι κλέφτες   ταράζουν   την κόρη.

The thief-M.PL.NOM   upset-PRS.3PL.ACT. the daughter-F.SG.ACC.

'The thieves upset the daughter.'
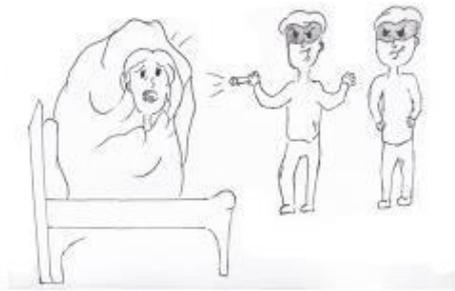
1
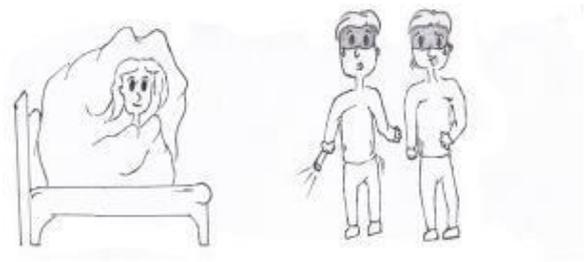
2

3. Ο πελάτης προβληματίζει την ταμία.

The customer-M.SG.NOM trouble-PRS.3SG.ACT the cashier-F.SG.ACC.

'The customer troubles the cashier.'

1   2

- Object-*Experiencer* rare psych verbs:

4. Η   νοσοκόμα   ξαφνιάζει   την ασθενή.

   The nurse-F.SG.NOM surprise-PRS.3SG ACT. the patient-F.SG.ACC.

   'The nurse surprises the patient.'
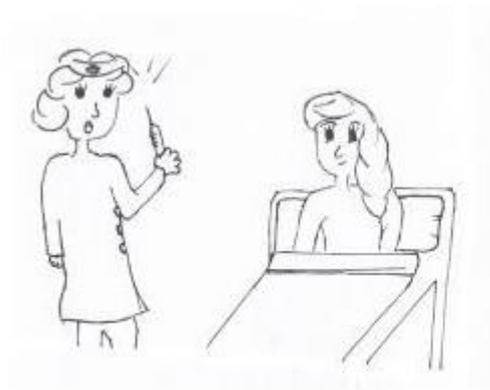
1

2

5. Οι εργάτες   τσαντίζουν   τον αγρότη.

The worker- M.PL.NOM enrage-PRS.3PL.ACT. the farmer-M.SG.ACC.

'The works enrage the farmer.'

1   2
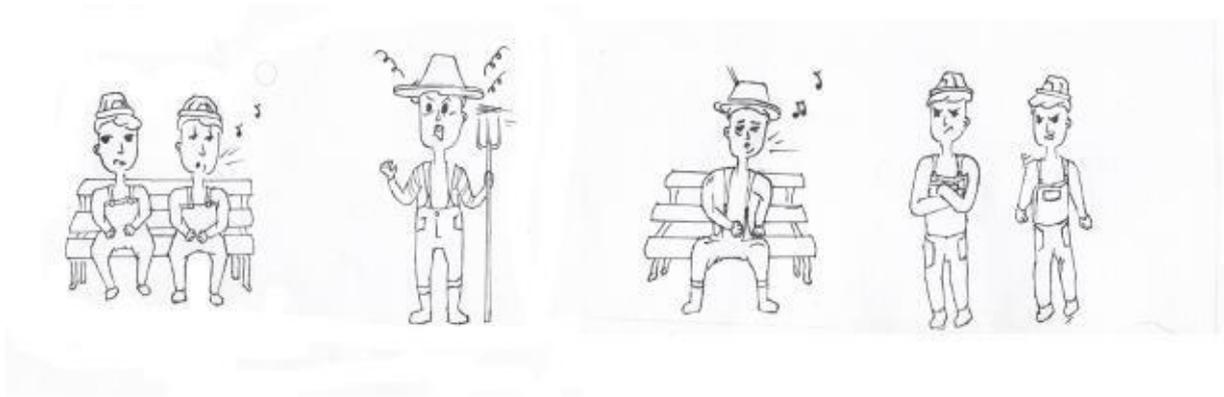
6. H γάτα   λυπεί   την κοπέλα.

The cat-F.SG.NOM. make.sad-PRS.3SG.ACT. the girl-F.SG.ACC.

'The cat makes sad the girl.'

1

2
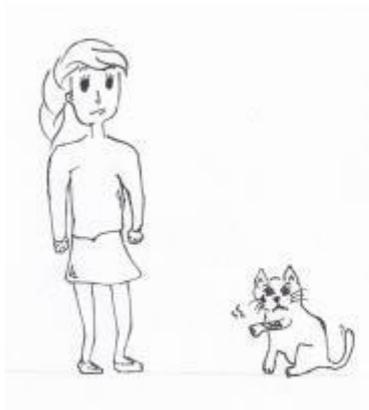
- Subject-*Experiencer* frequent psych verbs:

7. Η γάτα   φοβάται   με το σκύλο.

The cat-F.SG.NOM. frighten-PRS.3SG.PASS. with the dog-M.SG.ACC.

'The cat is frightened by the dog.

1   2
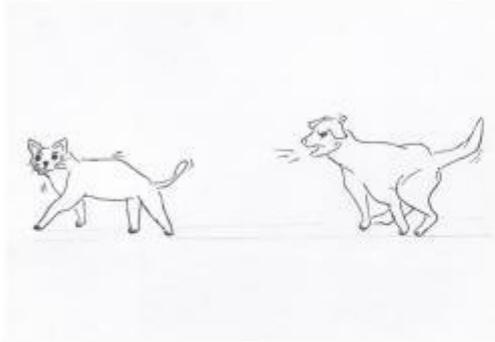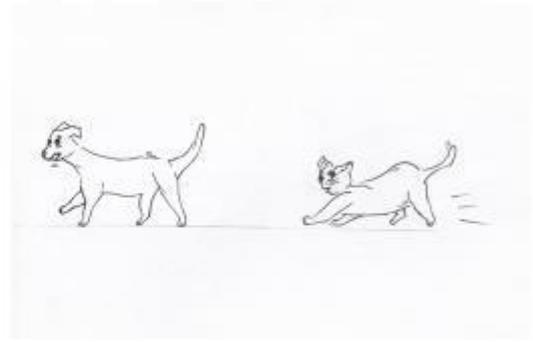
8. Η κόρη   ταράζεται   με τους κλέφτες.

The girl-N.SG.NOM. upset-PRS.3SG.PASS. with the thief-M.SG.ACC.

'The girl gets upset by the thieves.'
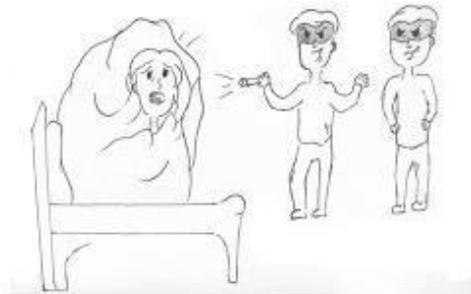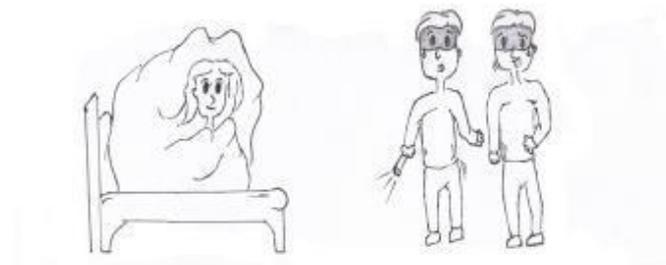
1   2

9. Η   ταμίας   προβληματίζεται   με   τον πελάτη.

The cashier-F.SG.NOM. trouble-PRS.3SG.PASS. with the customer-M.SG.ACC.

'The cashier is troubled by the customer.'

1   2
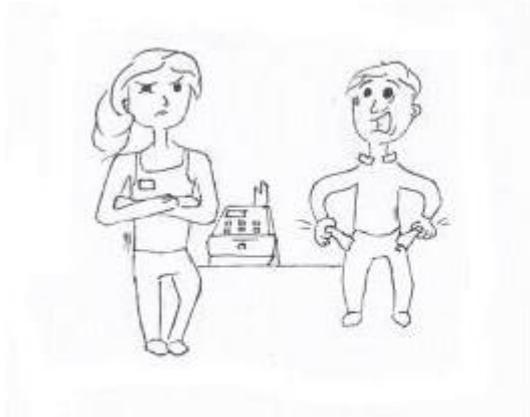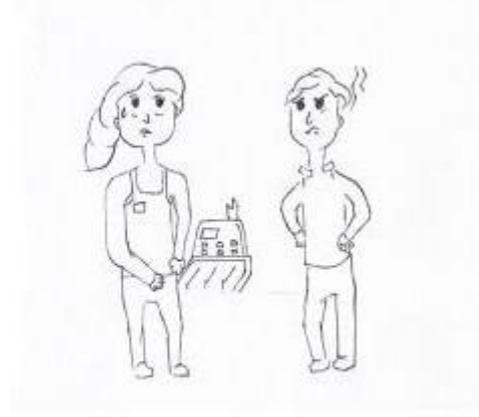
- Subject-*Experiencer* rare psych verbs:

10. Η   ασθενής   ξαφνιάζεται   με   τη νοσοκόμα.

    The patient-F.SG.NOM surprise- PRS.3SG.PASS. with the nurse-F.S.ACC.

    'The patient is surprised by the nurse.'
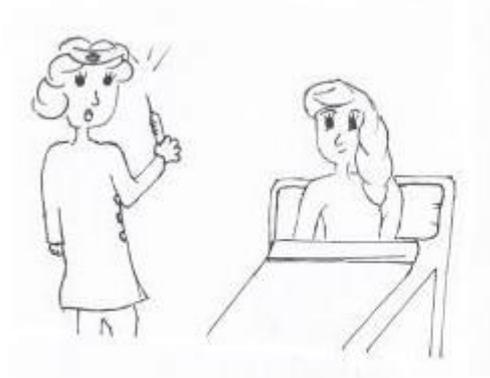
11. Ο αγρότης τσαντίζεται με τους εργάτες.

The farmer-M.SG.NOM. enrage-PRS.3SG.PASS. with the worker-M.PL.ACC.

'The farmer is enraged by the workers.'
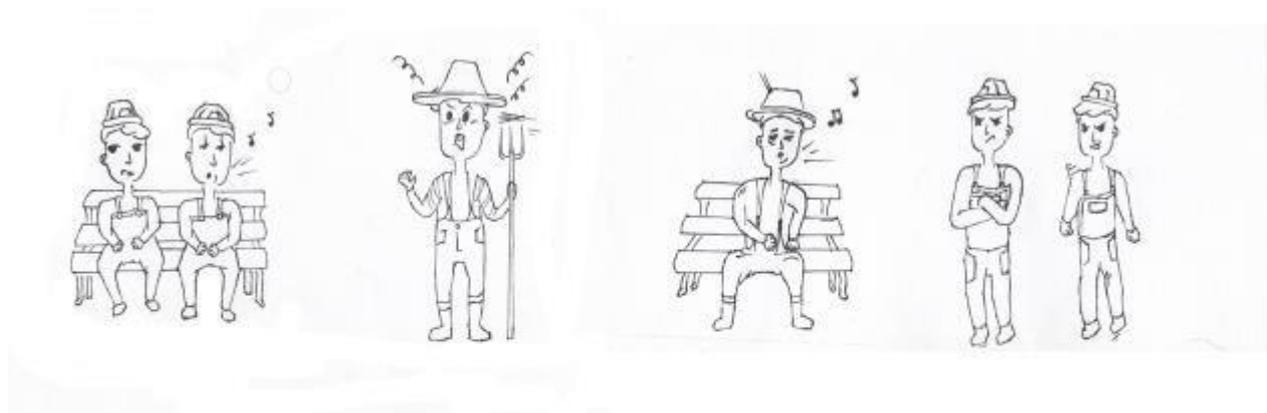
1   2

12. Η κοπέλα   λυπάται   με τη γάτα.

The girl-F.SG.NOM. feel.sad-PRS.3SG.PASS. with the cat-F.SG.ACC.

'The girl feels sad for the cat.'
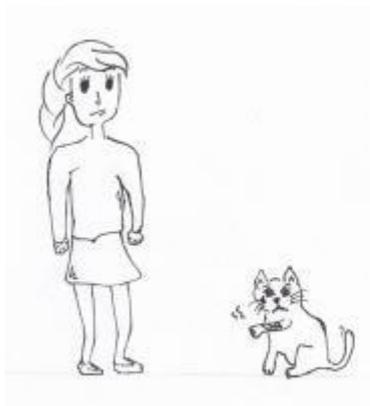
1

2

- Subject-*Agent* frequent non-psych verb:

13. Ο   ελέφαντας   πατάει   τον άνθρωπο.

The elephant-M.SG.NOM step.on- PRS.3SG.ACT. the human-M.SG.ACC.

'The elephant steps on the human.'
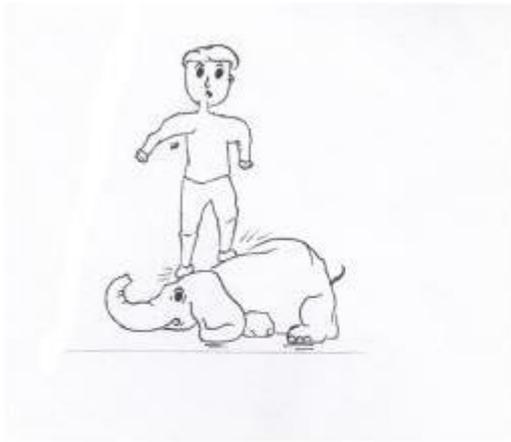
1   2

14. Ο   σκύλος   κυνηγάει   τη γάτα.

   The dog-M.SG.NOM. chase-PRS.3SG.ACT the cat-F.SG.ACC.

   'The dog chases the cat.'
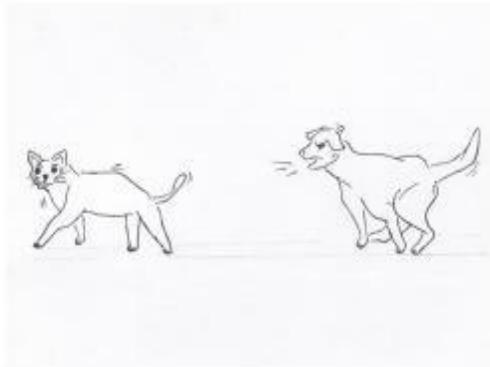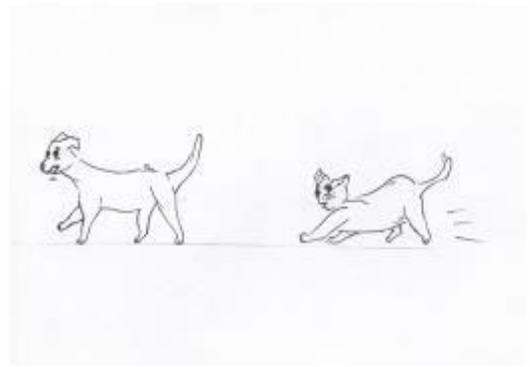
1   2

15. Ο   άντρας   σπρώχνει   τη γυναίκα.

The man-M.SG.NOM. push-PRS.3SG.ACT. the woman-F.SG.ACC.

'The man pushes the woman.'
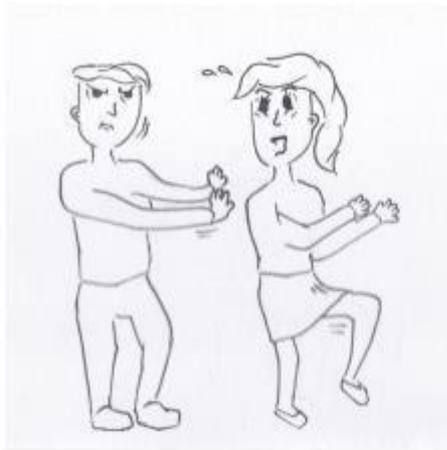
1

2

- Subject-*Agent* rare psych verb:

16. Ο   νεαρός   βρέχει   την κοπέλα.

    The youngster-M.SG.NOM make.wet- PRS.3SG.ACT the girl-F.SG.ACC.

    'The youngster makes wet the girl.'

1   2

17. Η   κοπέλα   κρύβει   το νεαρό.

The girl-F.SG.NOM. hide-PRS.3SG.ACT. the youngster-M.SG.ACC.

'The girl hides the youngster.'

1

2

18. Η   κοπέλα   σκεπάζει   την γιαγιά.

The girl-F.SG.NOM. tuck.in-PRS.3SG.ACT. the grandmother-F.SG.ACC.

'The girl tucks in the grandmother.'

1   2

- Object-*Agent* (by phrase) frequent non-psych verb:

19. Ο άνθρωπος   πατιέται   από   τον ελέφαντα.

   The human-M.SG.NOM. step- PRS.3SG.PASS. from   the elephant-M.SG.ACC.

   'The human was stepped by the elephant.'

1   2
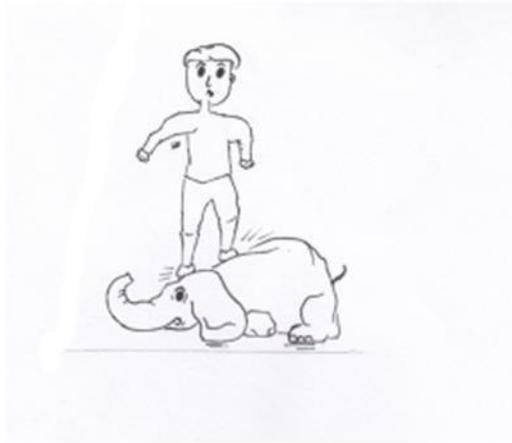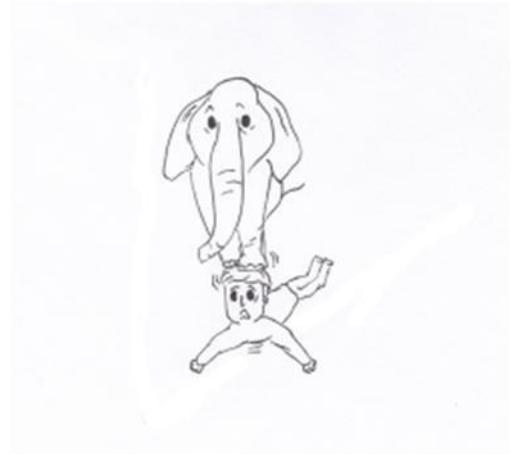
20. Η γάτα   κυνηγιέται   από το σκύλο.

The cat-F.SG.NOM. chase-PRS.3SG.PASS from the dog-M.SG.ACC.

'The cat is chased by the dog.'
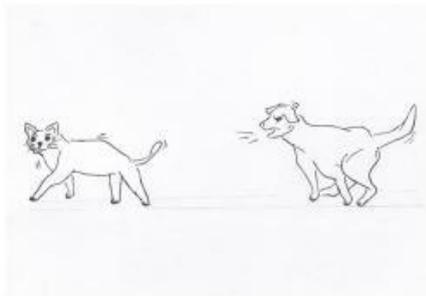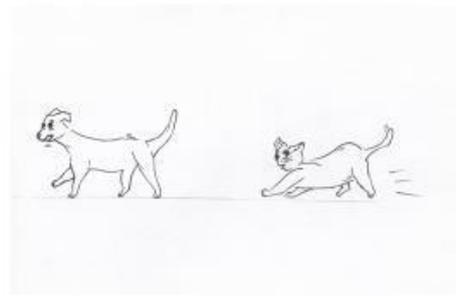
1   2

21. Η γυναίκα   σπρώχνεται   από τον άντρα.

The woman-F.SG.NOM. push-PRS.3SG.PASS from the man-M.SG.ACC.

'The woman is pushed by the man.'

1   2

- Object-*Agent* (by phrase) rare psych verb:

22. Η   κοπέλα   βρέχεται   από το νεαρό.

The girl-F.SG.NOM. make.wet- PRS.3SG.PASS. from the youngster-M.SG.ACC.

'The girl is made wet by the youngster.'
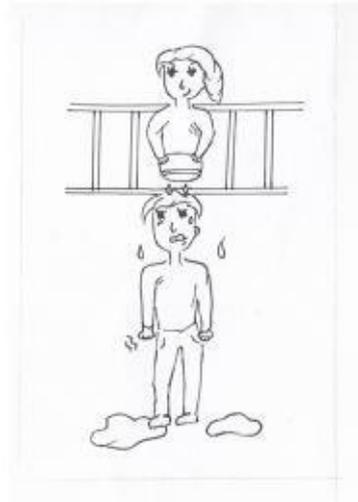
1   2

23. Ο   νεαρός   κρύβεται   από την κοπέλα.

The youngster-M.SG.NOM. hide-PRS.3SG.PASS. from the girl-F.SG.ACC.

'The youngster is hidden by the girl.'

1

2

24. Η γιαγιά   σκεπάζεται   από τη κοπέλα.

The grandmother-F.SG.NOM. tuck.in-PRS.3SG.PASS. from the girl-F.SG.ACC.

'The girl is tucked in by the girl.'

1   2

C. Working Memory Tests

1. Ευθεία Ανάκληση Ψηφίων

Ευθεία Ανάκληση Ψηφίων

Απαντητικό φυλλάδιο

Ονοματεπώνυμο ……………………………………………………………………

	έτος	μήνας	ημέρα
Ημερομηνία εξέτασης			
Ημερομηνία γέννησης			
Ηλικία			

Συμπληρωματικά Στοιχεία

Διεύθυνση ………………………………………………………………………..
………………………………………………………………………..

Τηλέφωνο …………………………………….

Συμπεριφορικά σχόλια κατά τη χορήγηση …………………………………………
………………………………………………………………………………………

Ευθεία Ανάκληση Ψηφίων

	Παραδείγματα	Απαντήσεις	Σκόρ (1 ή 0)
Π 1	2		
Π 2	1 5		
Π 3	7 4 8		

Πεδίο	Λίστα	Απαντήσεις	Σκόρ (1 ή 0)
1	4		
	9		
	7		
	3		
	8		
	1		
2	6 2		
	4 9		
	9 1		
	3 8		
	7 4		
	2 5		
3	4 8 3		
	2 6 1		
	7 4 3		
	3 7 6		
	1 8 4		
	6 9 4		
4	5 9 2 6		
	3 1 7 4		
	2 8 5 1		
	9 6 2 7		
	8 5 1 4		
5	6 1 4 2 5		
	3 2 8 4 1		
	7 4 2 5 9		
	3 7 6 1 4		
	4 9 2 5 7		
	1 5 8 3 6		
6	8 3 9 2 5 1		
	2 9 5 7 1 3		
	1 6 2 5 9 4		
	7 5 9 2 6 4		
	6 8 1 3 7 5		
	5 2 7 3 8 6		

Πεδίο	Λίστα	Απαντήσεις	Σκόρ (1 ή 0)
7	4 9 6 3 1 5 2		
	5 8 1 9 2 6 4		
	9 3 7 5 2 8 1		
	2 5 6 3 8 1 4		
	8 3 5 9 1 7 2		
	6 2 8 7 4 9 3		
8	1 7 5 6 9 3 2 4		
	9 2 8 1 7 4 6 3		
	8 6 4 2 9 3 1 7		
	6 1 3 7 2 9 4 8		
	5 2 9 4 7 3 1 6		
	3 8 4 1 5 2 7 9		
9	7 1 6 3 8 4 2 9 5		
	4 6 9 2 8 1 5 7 3		
	9 5 7 3 6 8 4 2 1		
	2 9 4 7 1 6 8 3 7		
	8 3 9 4 7 1 5 2 6		
	1 5 3 9 4 7 2 8 6		
10	4 8 4 6 1 7 6 5 3 4		
	7 0 4 3 7 5 9 5 8 4		
	0 4 2 8 5 5 8 5 5 4		
	1 4 9 5 2 3 8 1 4 9		
	6 6 7 9 3 7 8 1 9 1		
	3 7 6 9 6 4 8 5 1 8		
11	1 6 5 8 6 8 1 8 4 2 0		
	1 0 7 6 6 1 4 8 6 4 3		
	3 0 5 9 4 7 1 9 1 6 3		
	1 7 7 3 9 6 5 1 1 7 9		
	6 3 1 0 0 6 4 2 9 3 1		
	2 6 8 8 5 0 0 5 6 3 7		
12	4 8 5 0 3 2 6 6 1 5 4 3		
	9 8 0 6 0 5 9 9 8 5 8 2		
	8 5 2 5 7 1 1 8 4 1 5 9		
	5 1 5 0 6 8 4 9 9 2 7 9		
	7 7 3 5 6 1 1 9 6 2 4 0		
	8 4 0 9 6 4 6 7 6 6 7 3		
13	2 2 3 7 7 5 4 7 2 3 1 8 1		
	7 9 9 2 2 7 2 8 4 4 9 0 2		
	4 5 7 0 8 0 6 5 1 1 2 9 3		
	6 4 5 0 6 2 3 4 0 6 9 4 9		
	8 7 8 0 7 2 4 1 8 9 3 9 4		
	3 9 3 0 0 8 7 6 2 4 6 8 3		
	Σύνολο σωστών		
	Μνημονικό πεδίο		

4. Αντίστροφη Ανάκληση Ψηφίων

1. Αντίστροφη ανάκληση αριθμοσειρών

	Παραδείγματα	Απάντηση	Ανταπόκριση	Βαθμολογία (1 ή 0)
Π1	5 6			
Π2	7 4 6			

Πεδίο	Λίστα	Απάντηση	Ανταπόκριση	Βαθμολογία (1 ή 0)
2	2 8	(8-2)		
	5 3	(3-5)		
	4 6	(6-4)		
	8 1	(1-8)		
	9 2	(2-9)		
	1 3	(3-1)		
3	8 1 3	(3-1-8)		
	6 3 7	(7-3-6)		
	2 6 8	(8-6-2)		
	1 8 2	(2-8-1)		
	7 1 9	(9-1-7)		
	4 6 2	(2 -6-4)		
4	2 8 1 4	(4-1-8-2)		
	6 2 8 4	(4-8-2-6)		
	9 6 2 4	(4-2-6-9)		
	8 1 6 2	(2-6-1-8)		
	6 3 5 9	(9-5-3-6)		
	5 3 8 2	(2-8-3-5)		
5	8 1 3 9 2	(2-9-3-1-8)		
	3 5 8 2 6	(6-2-8-5-3)		
	2 9 7 3 1	(1-3-7-9-2)		
	4 6 3 1 9	(9-1-3-6-4)		
	5 8 1 3 6	(6-3-1-8-5)		
	7 1 3 6 2	(2-6-3-1-7)		
6	5 2 1 7 9 3	(3-9-7-1-2-5)		
	2 8 6 3 7 1	(1-7-3-6-8-2)		
	4 6 3 7 1 9	(9-1-7-3-6-4)		
	6 2 9 7 3 1	(1-3-7-9-2-6)		
	3 5 8 2 6 9	(9-6-2-8-5-3)		
	1 9 5 8 2 4	(4-2-8-5-9-1)		
7	8 3 5 2 9 7 1	(1-7-9-2-5-3-8)		
	7 9 2 6 3 5 8	(8-5-3-6-2-9-7)		
	8 5 2 9 6 3 1	(1-3-6-9-2-5-8)		
	9 6 2 8 1 4 7	(7-4-1-8-2-6-9)		
	3 1 8 2 6 9 5	(5-9-6-2-8-1-3)		
	5 3 7 1 9 6 4	(4-6-9-1-7-3-5)		
8	6 2 9 1 8 3 7 5	(5-7-3-8-1-9-2-6)		
	5 8 4 1 9 2 6 3	(3-6-2-9-1-4-8-5)		
	1 7 9 2 6 3 8 5	(5-8-3-6-2-9-7-1)		
	4 6 2 8 5 3 1 9	(9-1-3-5-8-2-6-4)		
	3 1 9 2 8 6 4 5	(5-4-6-8-2-9-1-3)		
	8 3 6 2 9 1 4 7	(7-4-1-9-2-6-3-8)		
9	4 7 1 9 6 2 5 3 8	(8-3-5-2-6-9-1-7-4)		
	7 3 5 8 6 2 9 4 1	(1-4-9-2-6-8-5-3-7)		
	9 3 7 2 5 8 1 4 6	(6-4-1-8-5-2-7-3-9)		
	4 6 2 8 1 9 7 3 5	(5-3-7-9-1-8-2-6-4)		
	1 9 2 6 8 5 3 7 4	(4-7-3-5-8-6-2-9-1)		
	6 4 1 3 8 2 9 5 7	(7-5-9-2-8-3-1-4-6)		
			Σύνολο σωστών απαντήσεων	
			Μνημονικό πεδίο	

D.   Consent Forms

1.   For participants with AD:

<div align="center">

ΕΝΗΜΕΡΩΣΗ ΚΑΙ ΣΥΓΚΑΤΑΘΕΣΗ ΦΡΟΝΤΙΣΤΩΝ/ΣΥΝΟΔΩΝ ΤΩΝ

ΣΥΜΜΕΤΕΧΟΝΤΩΝ

</div>

Τίτλος έρευνας: "Η κατανόηση του ρήματος στην Άνοια: μια προσέγγιση μέσω της ορισματικής δομής του ρήματος."

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Τοποθεσία και χρόνος συμμετοχής του συμμετέχοντα: Η έρευνα θα διεξαχθεί σε μία συνάντηση, η οποία μπορεί να λάβει χώρα είτε δια ζώσης είτε μέσω υπολογιστή /τάμπλετ. Η συνάντηση αυτή θα διαρκέσει περίπου 20 λεπτά και θα οριστεί από τον/την συμμετέχοντα/ουσα σε συνεννόηση με την ερευνήτρια. Κατά τη διάρκεια της, ο/η συμμετέχων/ουσα θα λάβει μέρος σε μία σειρά από δοκιμασίες, μέσα από τις οποίες θα ελεγχθεί η εργαζόμενη μνήμη και η κατανόηση και παραγωγή συναισθηματικού λόγου. Αξίζει να σημειωθεί ότι ο παραπάνω χρόνος δίνεται κατά προσέγγιση και περιλαμβάνει διάλλειμα, εάν ο/η συμμετέχων/ουσα το επιθυμεί.

Διαδικασία: Οι δοκιμασίες θα δοθούν στους υποψηφίους από την κα. Ζημιανίτη Ελένη, φιλόλογο και μετατυχιακή φοιτήτρια του Τμήματος Αγγλικής Γλώσσας και Φιλολογίας, Α.Π.Θ.. Κατά τη διάρκεια της πρώτης δοκιμασίας, ο/η συμμετέχων/ουσα καλείται να επαναλάβει τις αριθμητικές ακολουθίες που θα ακούσει από την ερευνήτρια με την ίδια σειρά. Κατά τη διάρκεια της δεύτερης δοκιμασίας, ο/η συμμετέχων/ουσα καλείται να επαναλάβει αντίστροφα τις αριθμητικές ακολουθίες που θα ακούσει από την ερευνήτρια. Κατά τη διάρκεια της τρίτης δοκιμασίας, ο/η συμμετέχων/ουσα καλείται να περιγράψει μια σειρά εικόνων με το ρήμα που δίνεται γραπτώς κάτω από την κάθε εικόνα. Τέλος, κατά τη διάρκεια της τέταρτης δοκιμασίας

ο/η συμμετέχων/ουσα ακούγοντας μια πρόταση από την ερευνήτρια καλείται να επιλέξει μία από τις δύο εικόνες, που του παρουσιάζονται, λέγοντας τον αριθμό της εικόνας που προτιμούν.

Κίνδυνοι και ωφέλειες: Οι συμμετέχοντες/ουσες που παίρνουν μέρος στην παραπάνω ακολουθία δοκιμασιών δεν διατρέχουν κανέναν απολύτως κίνδυνο. Η μόνη ενδεχομένως δυσκολία είναι ότι για λίγη ώρα δεν παίρνουν μέρος στις καθημερινές τους δραστηριότητες. Τα οφέλη της μελέτης είναι εξαιρετικά σημαντικά για το μέλλον δεδομένου ότι σχετίζονται με πιθανές αλλαγές στη διάγνωση και αντιμετώπιση ειδών Άνοιας προς όφελος του συνόλου, τόσο των πασχόντων όσο και των οικείων τους.

Διαφύλαξη προσωπικών δεδομένων: Η ανωνυμία των συμμετεχόντων διαφυλάσσεται απόλυτα. Καμία πληροφορία σας δε θα διατεθεί σε κανέναν, εκτός αν το επιθυμείτε εσείς. Για τη διαφύλαξη της ανωνυμίας χρησιμοποιούμε έναν αριθμό αντί για το όνομα σας. Μόνο η ερευνήτρια μπορεί να ξέρει σε ποιο όνομα αντιστοιχεί ο κάθε αριθμός.

Δικαιώματα: Και τώρα και στο μέλλον, έχετε το δικαίωμα να ζητήσετε οποιαδήποτε πληροφορία για την έρευνα γενικά ή τη συμμετοχή σας στην έρευνα. Οι κύριες ερευνήτριες είναι η κα Ζημιανίτη Ελένη φιλόλογος της ελληνικής γλώσσας και ο Δρ. Αναστάσιος Τσαγγαλίδης, Καθηγητής στο Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης. Μπορείτε να επικοινωνήσετε με την κα. Ζημιανίτη στο τηλέφωνο 697-4963101 και με τον κ. Τσαγγαλίδη στο 2310 997939. Τέλος, μπορείτε να αποσύρετε τη συμμετοχή σας από την έρευνα οποιαδήποτε στιγμή.

Συγκατάθεση συνοδού/φροντιστή συμμετέχοντα/ουσας: Εγώ, ως συνοδός/φροντιστής, διάβασα και κατανόησα την παραπάνω περιγραφή της έρευνας, τους στόχους της έρευνας, τη διαδικασία που θα ακολουθηθεί και τα δικαιώματα μου. Όλες οι ερωτήσεις μου έχουν απαντηθεί ικανοποιητικά και κατανοώ ότι οποιεσδήποτε περαιτέρω ερωτήσεις μου θα απαντηθούν. Δίνω εθελουσίως τη συγκατάθεση μου για να συμμετάσχει ο ασθενής στο ερευνητικό πρόγραμμα. . Έχω λάβει αντίγραφο του παρόντος εντύπου.

Υπογραφή συνοδού/φροντιστή συμμετέχοντα/ουσας   Ημερομηνία

Στοιχεία συμμετέχοντα/ουσας:

Ονοματεπώνυμο:

Ηλικία:

Ημερομηνία γέννησης:

Τα ελληνικά είναι η μητρική σας γλώσσα;   NAI   OXI

Μιλάτε άλλες γλώσσες;   NAI   OXI

Αν NAI, ποιες;

Έχετε κάποιο πρόβλημα όρασης;   NAI   OXI

Αν NAI, ποιο είναι το πρόβλημα;

Έχετε κάποιο πρόβλημα ακοής;   NAI   OXI

Αν NAI, ποιο είναι το πρόβλημα;

Τηλέφωνο επικοινωνίας:

Κατάλληλες ώρες για επικοινωνία:

Σας ευχαριστώ πολύ για τη συμμετοχή σας στο ερευνητικό πρόγραμμα!

2. For participants with MCI and Healthy participants:

ΕΝΗΜΕΡΩΣΗ ΚΑΙ ΣΥΓΚΑΤΑΘΕΣΗ ΣΥΜΜΕΤΕΧΟΝΤΩΝ

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επιλέξει μία από τις δύο εικόνες, που του παρουσίαζονται, λέγοντας τον αριθμό της εικόνας που προτιμούν.

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Υπογραφή συμμετέχοντα/ουσας   Ημερομηνία

Ονοματεπώνυμο:

Ηλικία:

Ημερομηνία γέννησης:

Τα ελληνικά είναι η μητρική σας γλώσσα;   ΝΑΙ   ΟΧΙ

Μιλάτε άλλες γλώσσες;   ΝΑΙ   ΟΧΙ

Αν ΝΑΙ, ποιες;

Έχετε κάποιο πρόβλημα όρασης;   ΝΑΙ   ΟΧΙ

Αν ΝΑΙ, ποιο είναι το πρόβλημα;

Έχετε κάποιο πρόβλημα ακοής;   ΝΑΙ   ΟΧΙ

Αν ΝΑΙ, ποιο είναι το πρόβλημα;

Τηλέφωνο επικοινωνίας:

Κατάλληλες ώρες για επικοινωνία:

     Σας ευχαριστώ πολύ για τη συμμετοχή σας στο ερευνητικό πρόγραμμα!

APPENDIX B.

Table 12

Kolmogorov Smirnov test of normality for all the variables

	Diagnosis	K-S test	df	p
	MCI	0.192	20	0.053
Production SPMT	AD mild	0.159	16	0.200
	AD moderate	0.310	11	0.004
	MCI	0.253	20	0.002
Comprehension SPMT	AD mild	0.167	16	0.200
	AD moderate	0.256	11	0.042
	MCI	0.180	20	0.090
Production_SPMT_Psychological_Verbs	AD mild	0.281	16	0.002
	AD moderate	0.227	11	0.117
	MCI	0.538	20	0.000
Production_SPMT_NonPsychological_Verbs	AD mild	0.382	16	0.000
	AD moderate	0.358	11	0.000
	MCI	0.221	20	0.012
Comprehension_SPMT_Psychological_Verbs	AD mild	0.182	16	0.165
	AD moderate	0.208	11	0.198
	MCI	0.452	20	0.000
Comprehension_SPMT_NonPsychological_Verbs	AD mild	0.227	16	0.027
	AD moderate	0.150	11	0.200
	MCI	0.452	20	0.000
Production_SPMT_Psychological_Frequent_Verbs	AD mild	0.320	16	0.000
	AD moderate	0.289	11	0.011
	MCI	0.300	20	0.000
Production_SPMT_Psychological_Rare_Verbs	AD mild	0.128	16	0.200
	AD moderate	0.318	11	0.003
	MCI	0.450	20	0.000
Production_SPMT_Nonpsych_Frequent_Verbs	AD mild	0.462	16	0.000

	AD moderate	0.492	11	0.000
	MCI	0.527	20	0.000
Production_SPMT_Nonpsych_Rare_Verbs	AD mild	0.448	16	0.000
	AD moderate	0.318	11	0.003
	MCI	0.391	20	0.000
Comprehension_SPMT_Psychological_Frequent_Verbs	AD mild	0.380	16	0.000
	AD moderate	0.171	11	0.200
	MCI	0.277	20	0.000
Comprehension_SPMT_Psychological_Rare_Verbs	AD mild	0.192	16	0.117
	AD moderate	0.226	11	0.121
	MCI	0.499	20	0.000
Comprehension_SPMT_Nonpsych_Frequent_Verbs	AD mild	0.271	16	0.003
	AD moderate	0.261	11	0.034
	MCI	0.450	20	0.000
Comprehension_SPMT_Nonpsych_Rare_Verbs	AD mild	0.329	16	0.000
	AD moderate	0.226	11	0.123
	MCI	0.225	20	0.009
Production_SPMT_Active_Voice	AD mild	0.214	16	0.049
	AD moderate	0.297	11	0.007
	MCI	0.339	20	0.000
Production_SPMT_Passive_Voice	AD mild	0.273	16	0.002
	AD moderate	0.307	11	0.005
	MCI	0.225	20	0.009
Production_SPMT_Active_Voice_Psych_Verbs	AD mild	0.313	16	0.000
	AD moderate	0.255	11	0.044
	MCI	0.538	20	0.000
Production_SPMT_Active_Voice_NonPsych_Verbs	AD mild	0.417	16	0.000
	AD moderate	0.343	11	0.001
Production_SPMT_Passive_Voice_Psych_Verbs	MCI	0.366	20	0.000
	AD mild	0.289	16	0.001

	AD moderate	0.346	11	0.001
Production_SPMT_Passive_Voice_NonPsych_Verbs	MCI	0.527	20	0.000
	AD mild	0.502	16	0.000
	AD moderate	0.382	11	0.000
Comprehension_SPMT_Active_Voice	MCI	0.261	20	0.001
	AD mild	0.172	16	0.200
	AD moderate	0.283	11	0.014
Comprehension_SPMT_Passive_voice	MCI	0.304	20	0.000
	AD mild	0.165	16	0.200
	AD moderate	0.183	11	0.200
Comprehension_SPMT_Active_Voice_Psych_Verbs	MCI	0.291	20	0.000
	AD mild	0.227	16	0.027
	AD moderate	0.323	11	0.002
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	MCI	0.424	20	0.000
	AD mild	0.307	16	0.000
	AD moderate	0.204	11	0.200
Comprehension_SPMT_Passive_Voice_Psych_Verbs	MCI	0.359	20	0.000
	AD mild	0.247	16	0.010
	AD moderate	0.266	11	0.029
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	MCI	0.499	20	0.000
	AD mild	0.348	16	0.000
	AD moderate	0.260	11	0.036

Table 13

Shapiro-Wilk test of normality for all the variables

	Diagnosis	S-W test	df	p
Production SPMT	MCI	0.920	20	0.097
	AD mild	0.970	16	0.841
	AD moderate	0.806	11	0.011
Comprehension SPMT	MCI	0.788	20	0.001
	AD mild	0.925	16	0.205
	AD moderate	0.878	11	0.099
Production_SPMT_Psychological_Verbs	MCI	0.909	20	0.061
	AD mild	0.846	16	0.012
	AD moderate	0.902	11	0.194
Production_SPMT_NonPsychological_Verbs	MCI	0.236	20	0.000
	AD mild	0.591	16	0.000
	AD moderate	0.787	11	0.006
Comprehension_SPMT_Psychological_Verbs	MCI	0.770	20	0.000
	AD mild	0.902	16	0.088
	AD moderate	0.923	11	0.345
Comprehension_SPMT_NonPsychological_Verbs	MCI	0.569	20	0.000
	AD mild	0.861	16	0.020
	AD moderate	0.950	11	0.641
Production_SPMT_Psychological_Frequent_Verbs	MCI	0.569	20	0.000
	AD mild	0.713	16	0.000
	AD moderate	0.878	11	0.099
Production_SPMT_Psychological_Rare_Verbs	MCI	0.806	20	0.001
	AD mild	0.938	16	0.326
	AD moderate	0.843	11	0.034
Production_SPMT_Nonpsych_Frequent_Verbs	MCI	0.532	20	0.002
	AD mild	0.546	16	0.000
	AD moderate	0.486	11	0.000

	MCI	0.351	20	0.000
Production_SPMT_Nonpsych_Rare_Verbs	AD mild	0.587	16	0.000
	AD moderate	0.867	11	0.071
	MCI	0.574	20	0.000
Comprehension_SPMT_Psychological_Frequent_Verbs	AD mild	0.687	16	0.000
	AD moderate	0.940	11	0.518
	MCI	0.806	20	0.001
Comprehension_SPMT_Psychological_Rare_Verbs	AD mild	0.933	16	0.269
	AD moderate	0.924	11	0.353
	MCI	0.447	20	0.000
Comprehension_SPMT_Nonpsych_Frequent_Verbs	AD mild	0.793	16	0.002
	AD moderate	0.822	11	0.018
	MCI	0.583	20	0.000
Comprehension_SPMT_Nonpsych_Rare_Verbs	AD mild	0.751	16	0.001
	AD moderate	0.864	11	0.064
	MCI	0.862	20	0.009
Production_SPMT_Active_Voice	AD mild	0.911	16	0.120
	AD moderate	0.736	11	0.001
	MCI	0.739	20	0.000
Production_SPMT_Passive_Voice	AD mild	0.899	16	0.076
	AD moderate	0.889	11	0.136
	MCI	0.862	20	0.009
Production_SPMT_Active_Voice_Psych_Verbs	AD mild	0.760	16	0.001
	AD moderate	0.899	11	0.181
	MCI	0.236	20	0.000
Production_SPMT_Active_Voice_NonPsych_Verbs	AD mild	0.631	16	0.000
	AD moderate	0.702	11	0.001
	MCI	0.711	20	0.000
Production_SPMT_Passive_Voice_Psych_Verbs	AD mild	0.824	16	0.006
	AD moderate	0.774	11	0.004

	MCI	0.351	20	0.000
Production_SPMT_Passive_Voice_NonPsych_Verbs	AD mild	0.379	16	0.000
	AD moderate	0.727	11	0.001
	MCI	0.784	20	0.001
Comprehension_SPMT_Active_Voice	AD mild	0.912	16	0.123
	AD moderate	0.743	11	0.002
	MCI	0.671	20	0.000
Comprehension_SPMT_Passive_voice	AD mild	0.900	16	0.080
	AD moderate	0.882	11	0.112
	MCI	0.774	20	0.000
Comprehension_SPMT_Active_Voice_Psych_Verbs	AD mild	0.874	16	0.032
	AD moderate	0.843	11	0.035
	MCI	0.632	20	0.000
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	AD mild	0.768	16	0.001
	AD moderate	0.922	11	0.332
	MCI	0.612	20	0.000
Comprehension_SPMT_Passive_Voice_Psych_Verbs	AD mild	0.828	16	0.007
	AD moderate	0.887	11	0.127
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	MCI	0.447	20	0.000

Table 14

Frequency of verbs according to Hellenic National Corpus

VERB	APPEARANCES	FREQUENCY
φοβίζω-άμαι	1.144	0.0223 ‰
ταράζω-ομαι	776	0.0151 ‰
προβληματίζω-ομαι	1.757	0.0338 ‰
ξαφνιάζω-ομαι	490	0.0094 ‰
τσαντίζω-ομαι	57	0.0007 ‰
λυπώ-άμαι	56	0.001 ‰
πατάω-ιέμαι	2.416	0.0472 ‰
κυνηγώ-ιέμαι	1.783	0.0351 ‰
σπρώχνω-ομαι	1.075	0.0208 ‰
κρύβω-ομαι	5.278	0.1035 ‰
σκεπάζω-ομαι	722	0.0138 ‰
βρέχω	727	0.0143 ‰

Table 15

Non-significant Mann-Whitney test statistics for the MCI - MCI control group comparison

	Mann-Whitney U	Z	p
Production SPMT	40.000	-4.908	0.000
Comprehension SPMT	70.000	-4.234	0.000
Production_SPMT_Psychological_Verbs	50.000	-4.685	0.000
Comprehension_SPMT_Psychological_Verbs	70.000	-4.238	0.000
Comprehension_SPMT_NonPsychological_Verbs	150.000	-2.355	0.019
Production_SPMT_Psychological_Frequent_Verbs	150.000	-2.355	0.019
Production_SPMT_Psychological_Rare_Verbs	50.000	-4.733	0.000
Comprehension_SPMT_Psychological_Frequent_Verbs	140.000	-2.615	0.009
Comprehension_SPMT_Psychological_Rare_Verbs	90.000	-3.790	0.000
Comprehension_SPMT_Nonpsych_Frequent_Verbs	170.000	-1.777	0.076
Comprehension_SPMT_Nonpsych_Rare_Verbs	150.000	-2.357	0.018
Production_SPMT_Active_Voice	75.500	-3.891	0.000
Production_SPMT_Passive_Voice	110.000	-3.346	0.001
Production_SPMT_Active_Voice_Psych_Verbs	60.000	-4.466	0.000
Production_SPMT_Passive_Voice_Psych_Verbs	120.000	-3.108	0.002
Comprehension_SPMT_Active_Voice	80.000	-4.029	0.000
Comprehension_SPMT_Passive_voice	110.000	-3.340	0.001
Comprehension_SPMT_Active_Voice_Psych_Verbs	100.000	-3.574	0.000
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	140.000	-2.619	0.009
Comprehension_SPMT_Passive_Voice_Psych_Verbs	130.000	-2.865	0.004
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	170.000	-1.777	0.076

Note. The labels "NonPsychological" and "NonPsych" are used for the Agent-verbs examined

Table 16

Non-significant Mann-Whitney test statistics for the AD mild - AD mild control group comparison

	Mann-Whitney U	z	p
Production SPMT	8.000	-4.913	0.000
Comprehension SPMT	16.000	-4.665	0.000
Production_SPMT_Psychological_Verbs	8.000	-4.934	0.000
Production_SPMT_NonPsychological_Verbs	88.000	-2.386	0.017
Comprehension_SPMT_Psychological_Verbs	16.000	-4.671	0.000
Comprehension_SPMT_NonPsychological_Verbs	32.000	-4.183	0.000
Production_SPMT_Psychological_Frequent_Verbs	64.000	-3.190	0.001
Production_SPMT_Psychological_Rare_Verbs	8.000	-4.919	0.000
Production_SPMT_Nonpsych_Frequent_Verbs	96.000	-2.104	0.035
Production_SPMT_Nonpsych_Rare_Verbs	96.000	-2.101	0.036
Comprehension_SPMT_Psychological_Frequent_Verbs	80.000	-2.660	0.008
Comprehension_SPMT_Psychological_Rare_Verbs	8.000	-4.931	0.000
Comprehension_SPMT_Nonpsych_Frequent_Verbs	56.000	-3.441	0.001
Comprehension_SPMT_Nonpsych_Rare_Verbs	72.000	-2.923	0.003
Production_SPMT_Active_Voice	24.000	-4.429	0.000
Production_SPMT_Passive_Voice	16.000	-4.702	0.000
Production_SPMT_Active_Voice_Psych_Verbs	24.000	-4.454	0.000
Production_SPMT_Active_Voice_NonPsych_Verbs	88.000	-2.388	0.017
Production_SPMT_Passive_Voice_Psych_Verbs	24.000	-4.472	0.000
Comprehension_SPMT_Active_Voice	8.000	-4.922	0.000
Comprehension_SPMT_Passive_voice	32.000	-4.175	0.000
Comprehension_SPMT_Active_Voice_Psych_Verbs	8.000	-4.939	0.000
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	64.000	-3.184	0.001
Comprehension_SPMT_Passive_Voice_Psych_Verbs	48.000	-3.687	0.000

	Mann-Whitney U	Z	P
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	72.000	-2.935	0.003

Note. The labels "NonPsychological" and "NonPsych" are used for the Agent-verbs examined

Table 17

Non-significant Mann-Whitney test statistics for the AD moderate - AD moderate control group comparison

	Mann-Whitney U	Z	P
Production SPMT	0.000	-4.264	0.000
Comprehension SPMT	0.000	-4.259	0.000
Production_SPMT_Psychological_Verbs	0.000	-4.276	0.000
Production_SPMT_NonPsychological_Verbs	0.000	-4.278	0.000
Comprehension_SPMT_Psychological_Verbs	0.000	-4.255	0.000
Comprehension_SPMT_NonPsychological_Verbs	0.000	-4.255	0.000
Production_SPMT_Psychological_Frequent_Verbs	5.500	-3.993	0.000
Production_SPMT_Psychological_Rare_Verbs	0.000	-4.324	0.000
Production_SPMT_Nonpsych_Rare_Verbs	5.500	-3.976	0.000
Comprehension_SPMT_Psychological_Frequent_Verbs	5.500	-3.957	0.000
Comprehension_SPMT_Psychological_Rare_Verbs	0.000	-4.266	0.000
Comprehension_SPMT_Nonpsych_Frequent_Verbs	16.500	-3.370	0.001
Comprehension_SPMT_Nonpsych_Rare_Verbs	0.000	-4.266	0.000
Production_SPMT_Active_Voice	0.000	-4.276	0.000
Production_SPMT_Passive_Voice	0.000	-4.294	0.000
Production_SPMT_Active_Voice_Psych_Verbs	0.000	-4.280	0.000
Production_SPMT_Active_Voice_NonPsych_Verbs	22.000	-3.083	0.002
Production_SPMT_Passive_Voice_Psych_Verbs	0.000	-4.330	0.000
Production_SPMT_Passive_Voice_NonPsych_Verbs	5.500	-4.021	0.000

Comprehension_SPMT_Active_Voice	0.000	-4.270	0.000
Comprehension_SPMT_Passive_voice	0.000	-4.259	0.000
Comprehension_SPMT_Active_Voice_Psych_Verbs	0.000	-4.297	0.000
Comprehension_SPMT_Active_Voice_NonPsych_Verbs	11.000	-3.657	0.000
Comprehension_SPMT_Passive_Voice_Psych_Verbs	0.000	-4.280	0.000
Comprehension_SPMT_Passive_Voice_NonPsych_Verbs	0.000	-4.267	0.000

Note. The labels "NonPsychological" and "NonPsych" are used for the Agent-verbs examined